

## Poster Presentations

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PP001

Anatomy and Morphology

### **DISTRIBUTION OF ION CHANNELS AND TRANSPORTER PROTEINS IN THE LATERAL WALL OF THE HUMAN COCHLEA-A SIM MICROSCOPY STUDY**

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Stria vascularis (SV) as well as other inner ear tissue components are rich in ion and water channel/transporter proteins. In the SV they are essential for maintaining endo-cochlear chemical composition and potential (EP) critical for hair cell function and hearing.

By using immunohistochemistry combined with confocal and super-resolution microscopy (SIM), we analyzed directly fixed \*human cochleae for proteins related to transportation of ions (ion transporters and ion channels) such as Kir4.1 (KCNJ10) and voltage-gated potassium channel proteins Kv7.1 (KCNQ1/KCNE1) in SV. Furthermore, we examined the expression of connexin 30/26 (Cx30/Cx26), ion transporters NKCC1 and Na<sup>+</sup>-K<sup>+</sup>-ATPase. Water channel proteins aquaporin2/4/5 and tight junction protein claudin and occluding 11 in human cochlea were also investigated.

Human SV was margined apically and basally by tight junctions (TJ) containing occludin and claudin 11. TJs encompass the enclave, assumingly maintaining a high intra-strial K<sup>+</sup> concentration and electro-chemical gradient; TJs also constitute an integral part of the blood-labyrinth barrier. The K<sup>+</sup> channel KCNJ10 (Kir 4.1), which generates the K<sup>+</sup> equilibrium EP, was expressed both in the intermediate and basal cells and partly co-localized with Cx26. NKCC1 encodes the furosemide-sensitive Na<sup>+</sup>/K<sup>+</sup>/2Cl<sup>-</sup> co-transporter and was found in the marginal cells. The KCNQ1 gene, which encodes the voltage-gated potassium channel Kv7.1 (KvLQT1) was expressed in the apical cell membrane of the marginal cells. The Cx26 and Cx30 protein expression using super-resolution structured illumination microscopy (SIM) showed closely associated homomeric GJ plaques. The association of Cx26 with the potassium channel KCNJ10 could explain the vulnerability to GJB2 gene disruption.

PP003

Animal Models and Molecular Approach

### **PROTECTIVE EFFECT IN HERBAL MEDICINE “SHIMOTSUTO” IN THE ZEBRAFISH LATERAL LINE AND MICE VESTIBULAR HAIR CELLS**

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The zebrafish lateral line is an efficient model system for the evaluation of chemicals that protect and damage hair cells. Hair cells can be easily labeled and imaged in vivo with fluorescence microscopy. We have reported a screening to rapidly assess drugs for possible protective effect against ototoxicity. In Japan, herbal medicine is very popular, and it is covered by national health insurance. These are consist of several herb, so that Kampo have several effect (e.g. Anti-oxidant, Anti-inflammatory, steroid-like effect). We have now screened the herbal medicine for protective effects to hair cells against aminoglycoside. Furthermore, the drug that protects hair cells in zebrafish was confirmed in utricle hair cells. CBA/N mice were used in this study. Utricles were exposed to herbal drug (1 mg/ml), and Neomycin (2 mM). After that, they were fixed in 4% paraformaldehyde. To label hair cells, immunohistochemistry were performed using anti-calmodulin antibody. The rate of survival vestibular hair cells was evaluated with the fluorescence microscope. Our results showed that the herbal medicine could protect hair cells against aminoglycoside ototoxicity.

PP004

Animal Models and Molecular Approach

**DEVELOPMENT OF MURINE MODEL OF BPPV: A PRELIMINARY STUDY**Chan Joo YANG<sup>1</sup>, Ji-Won LEE<sup>2</sup>, Sung-Jin KIM<sup>2</sup>, Chang-Wan LEE<sup>2</sup>, Hong Ju PARK<sup>1</sup><sup>1</sup>Department of Otolaryngology, Asan Medical Center, University of Ulsan College of Medicine, Korea<sup>2</sup>Department of Asan Institute For Life Science, Asan Medical Center, University of Ulsan College of Medicine, Korea

**Objectives:** Mammalian ears contain thousands of small particles called otoconia that sense linear acceleration and gravity. In human, detachment of these structures and subsequent entrapment in the semicircular canals can result in benign paroxysmal positional vertigo (BPPV), a common form of vertigo for which the molecular basis is not well known. Several proteins of the mammalian otoconia and otoconial membrane have recently been identified. In the present study, we developed murine model of BPPV and observed the changes of protein constituents of otoconia and otoconial membrane after the detachment of otoconia.

**Material and Methods:** Six-week-old CBA mice with normal Prayer's reflexes were used in this study. We induced detachment of otoconia by vibrating the head for 2 minutes. Utricles of mice were harvested before the head vibrating and 1 day, 1 week, 1 month and 3 months after the vibration. Under the scanning electron microscope (SEM), we calculated the deletion rate of otoconia within utricle using Image J software.

**Results:** The intact area percentage of otoconia within utricle were  $98.4 \pm 0.7\%$  before vibration, and  $93.8 \pm 3.0\%$ ,  $87.7 \pm 6.1\%$ ,  $61.8 \pm 27.9\%$  and  $50.8 \pm 14.5\%$  in 1 day, 1 week, 1 month and 3 months after the vibration, respectively and it decreased significantly over time after the vibration ( $P = 0.008$ ).

**Conclusion:** We developed murine model of BPPV by confirmation of the otoconia detachment after the vibration. Our results showed that there was long-term loss of otoconia in the utricle after vibration.

PP005

Animal Models and Molecular Approach

**VESTIBULAR EFFECT IN SINGLE CANAL OCCLUSION MOUSE MODEL BY CO<sub>2</sub> LASER**Hyun Ji KIM<sup>1</sup>, Mi Joo KIM<sup>2</sup>, Yu Jin MIN<sup>2</sup>, Jiyeon LEE<sup>2</sup>, Nam Beom KIM<sup>3</sup>, Gyu Cheol HAN<sup>4</sup><sup>1</sup>Department of Otorhinolaryngology, Inha University College of Medicine, Korea<sup>2</sup>Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea<sup>3</sup>Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea<sup>4</sup>Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea

**Background:** Semicircular canal (SCC) occlusion or plugging have been commonly chosen as a surgical treatment for benign paroxysmal positional vertigo or semicircular canal dehiscence syndrome. Even chemical or surgical labyrinthectomy and neurectomy damage spontaneous primary vestibular afferent, SCC occlusion can preserve its function still. A few papers had approved that SCC by a CO<sub>2</sub> laser doesn't cause a hearing damage, yet it is still histologically effective as canal plugging. However, the vestibular influence of canal occlusion was not consistent due to species difference, and also it hasn't been studied with mouse.

**Method:** We operated the ICR mouse ( $n = 15$ , aged 8–10 weeks, weighing 18–25 g) a posterior SCC occlusion by CO<sub>2</sub> laser. Then the mouse was estimated its gain at 0.04, 0.08, 0.16, 0.32 Hz with the peak velocity of 100 deg/s on earth vertical axis rotation. Furthermore, we measured time constants during off vertical axis rotation. All the values were given in the 2nd and the 4th week from the operation day.

**Results:** The gain of the occlusion model at 0.04-0.08-0.16-0.32 Hz in the 2nd week from the operation day were  $0.049 \pm 0.039$ ,  $0.128 \pm 0.079$ ,  $0.217 \pm 0.144$ , and  $0.317 \pm 0.155$  respectively. In the 4th week, it became  $0.073 \pm 0.084$ ,  $0.147 \pm 0.136$ ,  $0.256 \pm 0.255$ , and  $0.212 \pm 0.152$ .

**Conclusion:** By observing above data, we can induce the result that the bilateral single canal occlusion in mouse causes a remarkable ablation to vestibular function and this condition maintains at least for 4 weeks.

PP006

Animal Models and Molecular Approach

**C-FOS EXPRESSION IN THE STRIATUM FOLLOWING ELECTRICAL STIMULATION OF THE PERIPHERAL VESTIBULAR SYSTEM**Lucy STILES<sup>1</sup>, Yiwen ZHENG<sup>1</sup>, Ruth NAPPER<sup>2</sup>, Paul F SMITH<sup>1</sup><sup>1</sup>*Department of Pharmacology And Toxicology, School of Medical Sciences, University of Otago, New Zealand*<sup>2</sup>*Department of Anatomy, School of Medical Sciences, University of Otago, New Zealand*

Connections between the peripheral vestibular system and the basal ganglia have been sporadically studied in the past; however, the results of these studies are conflicting. In recent years there has been increasing interest in how these regions are connected and how vestibular signals affect striatal function. The aim of this study was to see if electrical stimulation of the peripheral vestibular system caused an up-regulation of the c-Fos protein in the striatum, since immediate early genes like c-Fos can be used as a marker of neuronal activation. Male Wistar rats ( $n = 5$  per group) were randomly allocated into either stimulation or sham groups. The animals were anaesthetised using urethane and a stainless-steel bipolar electrode was placed into the round window. Stimulated rats received unilateral electrical stimulation at 100 Hz, 350  $\mu$ A for 10 min. Animals were sacrificed at 90 min post-stimulation and the tissue fixed and frozen. Serial coronal sections throughout the striatum were cryosectioned using a random, systematic sampling design. c-Fos immunolabelling was performed and the total number of c-Fos positive cells was estimated using the optical disector stereological method. While initial analysis showed no significant changes in the overall number of c-Fos positive cells in either the ipsilateral or contralateral striatum, it is possible that further analysis of specific striatal subregions may show a change.

PP007

Animal Models and Molecular Approach

**BILATERAL VESTIBULAR LESIONS INCREASE SENSITIVITY TO NON-VESTIBULAR INDUCED THETA RHYTHM IN RATS**Phillip AITKEN<sup>1</sup>, Yiwen ZHENG<sup>1</sup>, Paul F SMITH<sup>1</sup><sup>1</sup>*Department of Pharmacology And Toxicology, University of Otago, New Zealand*

Following bilateral vestibular loss (BVL), spatial memory and learning are impaired and hippocampal theta rhythm (theta) is reduced in freely moving animals. This study aimed to determine whether the reduction in theta was due to a loss of vestibular sensory stimulation, or whether the hippocampus is no longer able to generate theta, using a non-vestibular stimulus (tail pinch) in a chemical model of vestibular loss while under anaesthesia. Rats underwent transtympanic injections of sodium arsenite to induce BVL or unilateral vestibular loss (UVL). Ninety days following lesioning, animals (BVL = 5; UVL = 5; sham = 5) were anesthetized and an electrode was inserted into the hippocampus to record field potentials. A tail pinch stimulus was given for alternating 60 second periods. Fast Fourier transforms were conducted on the raw EEG traces and the data were analysed with a linear mixed model analysis. A significant increase in low frequency theta activity (3–5 Hz) was found (Treatment  $P \leq 0.05$ ; Treatment\* Frequency  $P \leq 0.05$ ) in all BVL and UVL animals, compared to sham controls. These results indicate that the ability to produce hippocampal theta rhythm is retained following BVL or UVL. Cholinergic cells in the pedunculopontine tegmental nucleus (PPT) were counted using stereology. The PPT is involved in sensory integration and theta production. Both BVL and UVL animals were found to have significantly more cholinergic cells in the PPT than sham animals ( $P \leq 0.05$ ). The increase in cholinergic PPT cells may explain why somatosensory-induced hippocampal theta was increased following vestibular loss, suggesting a mechanism of multi-sensory compensation.

PP008

Autonomic Function and Vestibular Disorders

**ORTHOSTATIC TACHYCARDIA WITH DIFFERENT ONSET TIME IN PATIENTS WITH ORTHOSTATIC DIZZINESS****Hyun Ah KIM<sup>1</sup>**, Hyung LEE<sup>1</sup><sup>1</sup>*Department of Neurology, Keimyung University Dongsan Hospital, Korea*

**Objective:** To investigate autonomic and hemodynamic parameters in patients with different onset time of postural tachycardia syndrome (POTS) and orthostatic dizziness.

**Methods:** We retrospectively reviewed autonomic data from patients presenting as orthostatic dizziness. A standardized battery of autonomic tests, including the HUT test, Valsalva maneuver, heart rate deep breathing test, and quantitative pseudomotor axon reflex test using Finometer devices to record the beat-to-beat blood pressure (BP) and heart rate (HR) response was performed. The hemodynamic parameters, including systolic, mean and diastolic BP, HR, cardiac output, stroke volume (SV), and total peripheral resistance (TPR), were also collected during HUT test. According to onset time of POTS, we divided into early POTS (HR increase within 10 minutes) and late POTS (HR increase after 10 minutes).

**Results:** We identified 210 patients showed POTS during HUT test. 71% of patients were included in early POTS and 29% were late POTS. Patients with late POTS older than early POTS. After adjusting age, late POTS group showed lower supine and tilting HR, higher BP and TPR during tilting and lower HR change but higher TPR change during tilting. Cardiovascular parameters were all lower in late POTS group. BP response during phase IIL of Valsalva test and smaller sweat output on forearm were smaller in late POTS.

**Conclusion:** There may be a difference in the mechanism of POTS in younger versus older patients. Patients with late POTS are older ages with mild autonomic dysfunction. Decreased cardiovascular function may be related with delayed HR increase after tilting.

PP009

Autonomic Function and Vestibular Disorders

**USING CROSS-COUPLING STIMULATION TO REVEAL A SUDOMOTOR COMPONENT OF THE VESTIBULO-SYMPATHETIC REFLEX****Giovanni BERTOLINI<sup>1</sup>**, **Fausto ROMANO<sup>1,2</sup>**, Nicoletta CARAMIA<sup>1</sup>, Eugene NALIVAICO<sup>3</sup>, Dominik STRAUMANN<sup>1</sup><sup>1</sup>*Department of Neurology, University of Zurich, Switzerland*<sup>2</sup>*Department of Electrical, Computer And Biomedical Engineering, University of Pavia, Italy*<sup>3</sup>*Department of Biomedical Science And Pharmacy, University of Newcastle, Australia*

Sweating is known symptom related to onset of motion sickness. The characteristics of a sudomotor component of the vestibulo-sympathetic reflex were however never clarified. Our aim was to investigate sweating responses during cross-coupling stimulation ("roll while rotating") in healthy subjects. Subjects ( $n = 14$ ) were rotated at  $40^\circ/s$  around an earth-vertical yaw axis alone and in combination with sinusoidal earth-horizontal axis roll oscillations (0.2 Hz). Motion sickness was assessed every minute using a 1–10 scale, while recording DC and AC skin conductance levels (SCL) from the forehead.

Yaw rotation alone did not provoke nausea or variations of forehead sweating. During cross-coupling stimulation all subjects reported nausea (mean  $\pm$  SD:  $4.9 \pm 0.6$ ). Increase in forehead sweating started at relatively low nausea scores ( $2.7 \pm 0.4$ ) and even preceded nausea onset in 3 subjects. There was no association of DC-SCL signals with nausea levels. Higher levels of nausea ( $> 5$ ) were associated with higher amplitudes of AC-SCL deflections compared to nausea of lower levels ( $0.21 \pm 0.02 \mu S$  vs.  $0.10 \pm 0.01 \mu S$ ). During oscillation, the frequency of AC-SCL deflections closely related to the roll frequency independently from the level of nausea. AC-SCL deflections were always phase-locked to the chair roll oscillation up to  $0.05 \mu S$ , when detectable ( $n = 8$ ). For higher AC-SCL amplitudes, it was only possible to identify periods where these events were phase-locked.

Our findings suggest: (1) the existence of a sudomotor component of vestibulo-sympathetic reflex elicited by cross-coupling stimulation and (2) facilitatory effects on this reflex from brain regions involved in nausea perception.

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PP010

Benign Paroxysmal Position Vertigo

**EFFICACY OF COMPUTER-CONTROLLED AND MODIFIED ROLL MANEUVER FOR TREATMENT OF GEOTROPIC LATERAL CANAL BPPV****Hong LU**<sup>3</sup>, Xizheng SHAN<sup>1</sup>, Xin PENG<sup>1</sup>, Entong WANG<sup>2</sup><sup>1</sup>*Department of Otolaryngology Head And Neck Surgery, Institute of Vertigo, General Hospital of Chinese People's Armed Police Forces, China*<sup>2</sup>*Department of Otolaryngology Head And Neck Surgery, Air Force General Hospital, China*<sup>3</sup>*Department of Ent & Hn Surgery Department, The 2nd Hospital of Hebei Medical University, China*

To evaluate the short-term efficacy of computer-controlled and modified roll maneuver (CMRM) versus conventional roll maneuver (RM) for treatment of geotropic lateral canal benign paroxysmal positional vertigo (BPPV).

**Patients:** One hundred consecutive patients diagnosed as having unilateral idiopathic geotropic lateral canal BPPV with a duration of symptoms of less than 2 weeks. 18 men and 34 women) were treated with CMRM that was composed of three sequential 360-degree rotations and 48 patients (aged 30Y71 yr; mean, 52.4 yr; 20 men and 28 women) treated with RM that consisted of one 360-degree rotation.

**Main Outcome Measures:** Resolution of vertigo on the supine roll test at 48 hours after initial maneuver and the number of maneuvers required for final resolution of vertigo were main outcome measures to assess the efficacy of treatment.

**Results:** On the supine roll test at 48-hour follow-up after initial maneuver, 44 (84.6%) of 52 CMRM-treated patients and 23 (54.2%) of 48 RM-treated patients had resolution of vertigo ( $p < 0.01$ ). All patients obtained final resolution of vertigo with a maximum of five maneuvers in each group, but the CMRM group had less mean number of maneuvers required for final resolution of vertigo compared with the RM group (1.23  $\pm$  0.39 versus 1.63  $\pm$  0.68,  $p < 0.05$ ). No significant adverse effects and complications occurred aside from two patients with conversion into posterior canal BPPV in each treatment.

**Conclusion:** The CMRM consisting of three sequential 360-degree rotations for geotropic lateral canal BPPV has a higher success rate.

PP011

Benign Paroxysmal Position Vertigo

**DIAGNOSIS AND CRP-THERAPY FOR THE DIFFERENT TYPES OF BENIGN PAROXYSMAL POSITIONAL VERTIGO****Hong LU**<sup>2</sup>, Junhai TIAN<sup>1</sup>, Haitao XUE<sup>1</sup>, Yanfeng DONG<sup>1</sup>, Yuling ZHAO<sup>1</sup><sup>1</sup>*Department of E. N. T. And H. N Surgery, The 1st. Hospital of Hebei Medical University, China*<sup>2</sup>*Department of E.n.t. And H.n Surgery, The 2nd. Hospital of Hebei Medical University, China*

**Objective:** To discuss the diagnosis of the different types of benign paroxysmal positional vertigo (BPPV) and its treatment by canalith repositioning procedure (CRP).

**Methods:** 96 patients with BPPV were diagnosed by positioning nystagmus and treated by CRP from January 2005 to December 2007.

**Results:** After one or two treatment sessions of CRP, the symptoms disappeared completely in 84 of 96 patients (87.5%). 12 patients had no the vertigo symptoms but showed dizziness or lightheadedness which has no relation with body position-change. These symptoms disappeared in 10 patients in one week and 2 patients in two week.

**Conclusion:** There are many differences among the diagnostic methods for the different types of BPPV. The CRP therapy is safe and effective for BPPV and should be applied for all patients when the diagnosis is defined.

PP012

Benign Paroxysmal Position Vertigo

**FACTORS ASSOCIATED TO CANALITH REPOSITIONING PROCEDURE FAILURE IN BENIGN PAROXYSMAL POSITIONAL VERTIGO PATIENTS****Jose Mario JALIL**<sup>1,2</sup>, Julian Felipe MOLANO<sup>1</sup>, Alejandro RESTREPO<sup>1</sup>, Sara Maria VELEZ<sup>1</sup>, Damian MARTINEZ<sup>3</sup><sup>1</sup>*Department of Otorhinolaryngology, Universidad De Antioquia, Colombia*<sup>2</sup>*Department of Otorhinolaryngology, Clinica Orlant, Colombia*<sup>3</sup>*Department of Medical Research, Universidad De Antioquia, Colombia***Purpose:** To explore factors associated to treatment failure by canalith repositioning procedures (CRP) in benign paroxysmal positional vertigo (BPPV) patients and to describe its clinical and socio-demographical characteristics.**Methods:** An observational cohort study was conducted by a review of medical records of vertigo cases at Clinica ORLANT in Medellin, Colombia.**Results:** This study included eighty-six patients with BPPV diagnosis who had undergone CRP and clinical follow-up for one to four weeks to evaluate treatment failure. Here, 91.9% were women with median age of 63.06 years (28 to 86), 44.2% had left posterior canal BPPV, 46.5% had right posterior canal BPPV, 1.2% had bilateral posterior canal BPPV, 1.2% had left lateral canal BPPV, 4.7% had right lateral canal BPPV, and 2.3% had bilateral lateral canal BPPV. Also, 56.97% of patients presented treatment failure, where an association was identified between vestibular neuritis (OR: 1.787 CI: 1.478–2.161) and migraine (OR: 1.822 CI: 1.497–2.217). No statistically significant associations were found between comorbidities such as dyslipidemia, high blood pressure, diabetes mellitus, hypothyroidism, and traumatic brain injury. Prior consumption of Ginkgo Biloba found in 22.1% of patients was associated with a lower risk of presenting treatment failure (OR: 0.347 CI: 0.121–0.998). In addition, 17.4% of patients were referred to vestibular rehabilitation therapy.**Conclusion:** The risk factors for treatment failure by CRP in BPPV are a controversial topic and require further research. Due to the sample size, strong associations cannot be determined; however, the possible protective role of Ginkgo Biloba remains an issue to be considered.

PP013

Benign Paroxysmal Position Vertigo

**DDPRM (DOWN DYNAMIC PARTICLES REPOSITIONING MANEUVER): A NEW MANEUVER TO TREAT BOTH PC AND LC-BPPV AT THE SAME TIME****Thomas RICHARD VITTON***Department of Ent, Private Clinic of Marignane, France*

Canaliths involving both posterior and lateral canals are frequent. This new therapeutic maneuver using a mechanical assistance can treat both involvements simultaneously. One hundred twenty subjects who presented with BPPV and positional nystagmus typical of both posterior and lateral canalithiasis of the same side were included. The TRV armchair allows rotation of patients in all semi-circular canals planes while wearing infrared video goggles. An abutment with shocks absorber permits to briskly smoothly stop the rotation of the horizontal rotation of the chair when the head of the patient becomes 45° under the horizontal plane. The maneuver consists to make 6 series of 8 smooth shocks on the shocks absorber placing prior the involved ear toward the floor, nose turned at 90° from the ceiling, in supine position 45° under the horizontal plane. Each series is made after a 45° more rotation toward the safe side to make the sixth position 45° nose to the floor on the healthy side. These series of shocks permit to give to the very little particles, that could be too light to progress under the action of gravity, some hypergravity that helps its to move.

One hundred five patients were totally freed of symptoms with one session. Some persistent unsteadiness or drunkenness sensations after the physiotherapy made to treat a PC-BPPV, usually named post-BPPV otolithic syndrome, could be some mild canalithiasis in the lateral canal of the same side and could be successfully treated with this new maneuver.

PP014

Benign Paroxysmal Position Vertigo

**EXPERIMENTAL STUDY ON THE ETIOLOGY OF BPPV USING A ROTARY SHAKER****Koji OTSUKA**<sup>1</sup>, Miho SHIROMORI<sup>1</sup>, Mamoru SUZUKI<sup>1</sup>, Ujimoto KONOMI<sup>1</sup>, Taro INAGAKI<sup>1</sup>, Shigetaka SIMIZU<sup>1</sup>, Noriko NAGAI<sup>1</sup>, Yasuo OGAWA<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Tokyo Medical University, Japan*

**Introduction:** We reported that mechanical vibration by surgical drill applied to the ear could induce otoconial dislodgement using isolated labyrinthine models. It was suspected that external vibration to the ear is one of the causes of BPPV. A drawback of the stimulation using surgical drill is too strong and not physiological. A rotary shaker was used in this experiment since this stimulus is comparatively weak and physiological.

**Methods:** Normal labyrinths and labyrinths with vestibular dysfunction created by injecting gentamicin into the perilymphatic space were used. The labyrinth preparation was placed on a rotary shaker (2.3 Hz). After 30 minutes, the otoconial dislodgement to the posterior semicircular canal was checked. The morphology of the utricular macula was also investigated.

**Results:** In the normal models ( $n = 16$ ), the otoconial mass was detached in none of the labyrinth preparations. In the vestibular dysfunction models ( $n = 19$ ), the otoconial mass was detached in 8 out of 19 (42%). Pathologically the sensory hairs reduced and the sensory cells became atrophic after GM injection.

**Discussion:** We confirmed that the otoconia would not be easily dislodged from the utricular macula by weak stimulation. Fine morphological studies have shown that the otoconia of the utricle are connected to each other by fine fibrils and are embedded in a gelatinous substance consisting of mucopolysaccharides. The whole otoconial mass is covered by a supra-otoconial layer. These structures can protect the otoconia from the weak stimulation. GM injection induced change the utricular macula and led to easy dislodgement of the otoconia from the macula.

PP015

Benign Paroxysmal Position Vertigo

**EFFECTS OF HEAD POSITION IN SLEEP ON REMISSION OF SYMPTOMS IN PATIENTS WITH BENIGN PAROXYSMAL POSITIONAL VERTIGO****Sho TAKAOKA**<sup>1</sup>, **Go SATO**<sup>1</sup>, Kazunori MATSUDA<sup>1</sup>, Kazunori SEKINE<sup>1</sup>, Noriaki TAKEDA<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Institute of Biomedical Science, Tokushima University Graduate School, Japan*

**Conclusion:** These findings suggest that otoconial debris dislodged from the utricle is easy to fall into the posterior semicircular canal (PSCC) or the horizontal semicircular canal (HSCC) of the undermost ear during sleep, but not to exit from the uppermost ear in patients with benign paroxysmal positional vertigo (BPPV).

**Objective:** The aim of the present study was two-fold: (1) To examine the association between the preferred side of head-lying during sleep and the side of the affected ear in patients with both posterior canal BPPV (P-BPPV) and horizontal canal BPPV (H-BPPV). (2) To see whether that position affects the time course in remission of their positional vertigo.

**Method:** One hundred sixteen patients with P-BPPV and 40 patients with H-BPPV who showed the habitual preference for right or left side sleeping position were included in this study.

**Results:** The side of the affected ear was significantly associated with the head-lying side during sleep in patients with both P-BPPV and H-BPPV. However, the head-lying side during sleep did not affect the remission rate of their positional vertigo.

PP016

Benign Paroxysmal Position Vertigo

**RECURRENCE OF BPPV AFTER THE REMISSION****Byungkun KIM**<sup>1</sup>, Soohyun CHO<sup>1</sup><sup>1</sup>*Department of Neurology, Eulji Hospital, Korea*

**Background:** BPPV is the most common cause of a recurrent vertigo. Although it is easily diagnosed and treatable, it frequently recurs. Nevertheless, the clinical characteristics of recurrence of BPPV after the remission have not been systematically evaluated.

**Method:** We investigated 1844 patients with BPPV who were symptom free more than 1 month after the remission of symptoms and signs of BPPV. The involving canal and side of recurrence were evaluated. The factors affecting the side of lesion in recurrence were also analyzed.

**Results:** Eighty nine patients who have recurrence from posterior canal to posterior canal were enrolled. Seventy four of 89 patients experience recurrence at the same side (left to left or right to right). The same canal was more frequently involved in 70 patients ( $p > 0.05$ ).

**Conclusion:** Our data revealed that the ipsilateral ear and same canal were more frequently involved in patients with BPPV after the remission.

PP017

Benign Paroxysmal Position Vertigo

### **HORIZONTAL CANAL BPPV WITH PERSISTENT GEOTROPIC DIRECTION CHANGING POSITIONAL NYSTAGMUS**

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The purpose of this study was to identify the clinical characteristics of horizontal canal benign paroxysmal positional vertigo (h-BPPV) with persistent geotropic direction changing positional nystagmus (DCPN). One hundred thirty-two patients diagnosed as the geotropic subtype of h-BPPV were analyzed retrospectively. Patients were classified into two groups: persistent h-BPPV (ph-BPPV) group which means h-BPPV showing persistent ( $> 1$  minute) geotropic DCPN and short duration h-BPPV (sh-BPPV) group that means h-BPPV with short duration ( $\leq 1$  minute) geotropic DCPN. We compared the clinical characteristics and treatment outcomes between the two groups. The study included 34 patients with ph-BPPV and 98 patients with sh-BPPV. There were no differences between the two groups in age, distribution of sex and the affected side. The ph-BPPV group had higher secondary BPPV preponderance and dizziness handicap index (DHI) score compared to the sh-BPPV group. The ph-BPPV group required higher number of canalith repositioning procedures (CRPs) until resolution and higher multiple/single CRP ratio than the sh-BPPV group. In addition, the ph-BPPV group showed longer duration until the remission of subjective symptoms (vertigo, dizziness) compared to the sh-BPPV group. ph-BPPV was more frequently associated with secondary causes of BPPV and demonstrated higher DHI score, total number of CRP, and longer remission duration of subjective symptoms compared to sh-BPPV. This information may be helpful for clinicians in counseling and managing the patients with persistent geotropic DCPN h-BPPV.

PP018

Benign Paroxysmal Position Vertigo

### **BENIGN PAROXYSMAL POSITIONAL VERTIGO INDUCED BY YOGA PROGRAM**

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Yoga is a representative mind-body therapy of complementary and alternative medicine. Yoga has been reported to improve various stress-induced complaints of the mind and body. However, reports on yoga-associated adverse events have also been increased. We present 2 cases of BPPV induced by same yoga program.

Case 1 > A 57-year-old female was admitted to the emergency unit with the complaint of 1 day dizziness of whirling nature accompanied by nausea and vomiting. The patient showed spontaneous, left-beating mixed torsional nystagmus. Left-beating horizontal nystagmus on the lying-down test and right-beating horizontal nystagmus on the head bending test was demonstrated, respectively. Geotropic direction-changing horizontal nystagmus was demonstrated on both sides during the supine roll test. These findings collectively led to the impression of geotropic variant of the right lateral semicircular canal BPPV.



Case 2 > Another 61-year-old female visited the outpatient department of neurology with the 2 days' dizziness of same nature accompanied by nausea and sway. The patient showed right-beating horizontal torsional mixed nystagmus on the left Dix-Hallpike test and reversed left –beating nystagmus at sitting position. These findings are suggestive of canalolithiasis variant of the left posterior canal BPPV.

These two patients' dizziness was developed after same yoga program with prolonged head-hanging position and head-bending position. BMD study demonstrated osteopenia in case 1 and osteoporosis in case 2.

Though the frequency of BPPV in yoga is low, person with osteoporosis should be careful in exercising yoga program especially prolonged head-hanging or head-bending position.

PP019

Benign Paroxysmal Position Vertigo

### CAN WE PREDICT THE TYPE OF BENIGN PAROXYSMAL POSITIONAL VERTIGO BASED ON THE PREVIOUS EVENT WHEN IT RECURS?

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**Background and Objectives:** Self-administration of canalith repositioning procedures (CRP) may be more easily applied when benign paroxysmal positional vertigo (BPPV) recurs if each patient has a predilection for a specific canal and the involved canal can be predicted from the previous event.

**Methods:** We analyzed the involved side (right, left, and bilateral) and affected canal (posterior, geotropic horizontal, apogeotropic horizontal, anterior, and mixed) in 199 pairs of consecutive BPPV from 146 patients at the Dizziness Clinic of Seoul National Bundang Hospital from 2003 to 2015. Recurrence was defined when the patients redeveloped positional vertigo and nystagmus at least one week after resolution of the previous positional vertigo and nystagmus.

**Results:** During the initial attack, the involved canals were posterior in 113 (56.8%), geotropic horizontal in 49 (24.6%), apogeotropic horizontal in 29 (14.6%), anterior in 3 (1.5%), and mixed in 5 (2.5%). The right ear was affected in 89 (44.7%), the left ear in 108 (54.3%), and both ears in 2 (1.0%). During the recurrences, the proportions of involved canal ( $p = 0.353$ ) and affected side ( $p = 0.835$ ) did not differ from those of the initial event (Pearson  $X^2$  test). However, only 30% of the patients showed the recurrence in the same canal on the same side.

**Conclusion:** The pattern of recurrences was usually discordant in our patients with BPPV. Education for self-administration of a specific CRP based on the type of previous event may have a limitation in treating this frequently recurrent disorder.

PP020

Benign Paroxysmal Position Vertigo

### VISUAL DETERMINATION OF THE INVOLVED CANAL IN HORIZONTAL CANAL BPPV

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**Background:** This study investigated the accuracy of visual determination of the involved canal in benign paroxysmal positional vertigo involving the horizontal semicircular canal (hBPPV) and clarified the factors affecting the accuracy of the decision.

**Methods:** We developed video clips from the 44 patients with hBPPV, and quantitative analyses of the induced nystagmus using video-oculography. The video clips were shown twice to 11 experienced medical personnel and 14 medical students who were asked to determine the affected side by comparing intensity of the nystagmus induced

during head turning to each side while supine. The analyzed parameters included the presence of prior experience, and absolute and relative (the difference divided by the sum) differences in the peak slow phase velocity (pSPV) of the nystagmus induced in each direction

**Results:** The proportion of the correct answer was 83.5% after the first view, and was increased to 96% after the second observation without a difference between the experienced personnel and the students (t-test,  $p = 0.559$ ). The relative difference of pSPV was better correlated with correctness of the answers (Spearman's  $\rho = 0.672$ ,  $p < 0.0001$ ) than the absolute difference (Spearman's  $\rho = 0.337$ ,  $p = 0.025$ ). The area under the ROC curve for the relative difference of pSPV was 0.75 ( $p = 0.010$ ), and that for the absolute difference was 0.58 ( $p = 0.418$ ). The cutoff of the relative difference was 23.5% for the best sensitivity (92.3%).

**Conclusions:** In hBPPV, the affected side can be reliably determined on visual inspection of the induced nystagmus when the relative difference of the pSPV is more than 25%.

PP021

Benign Paroxysmal Position Vertigo

**A PRAGMATIC STRATEGY FOR THE EVALUATION OF PAROXYSMAL POSITIONAL DOWNBEAT NYSTAGMUS WITH VERTIGO**

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Anterior canal benign paroxysmal positional vertigo (aBPPV) is a peripheral condition associated with positional downbeat torsional nystagmus in the plane of the affected anterior semicircular canal. This exam finding, however, is also a “red flag” for more severe central aetiologies of vertigo and episodic vertical oscillopsia. Herein, we present two cases of positional downbeat with vertigo: one case of aBPPV and one case of central paroxysmal positional downbeat nystagmus caused by a Rosette-forming glioneuronal tumor of the midline cerebellum. We have previously described a pragmatic strategy for differential diagnosis, performing a therapeutic maneuver intended to resolve aBPPV as nystagmus associated with a central cause should not resolve with physical maneuvers. With the second case we demonstrate that a central case may temporarily resolve with physical maneuvers. In conclusion while a pragmatic strategy may be used for topodiagnosis, a patient reevaluation is mandatory.

PP022

Benign Paroxysmal Position Vertigo

**RELATIONSHIP AMONG VISUAL DEPENDENCE, BALANCE AND SPATIAL ORIENTATION AND ABNORMAL LOADING OF THE LABYRINTH IN BPPV**

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People with benign paroxysmal positional vertigo are thought to have otoconial particles displaced from the utricle into the posterior semicircular canal. This change in the inertial load distributions of the labyrinth on one side has the potential to affect spatial perception. Using general linear mixed models, we compared 23 healthy controls to 18 people with unilateral BPPV on the Romberg test on complaint foam, the rod-and-frame test and a mental rotation test. In normals, but not BPPV subjects, balance scores were moderately correlated with visual dependence, suggesting that reliance on visual cues affects balance as well as orientation to the visual vertical. BPPV and control

subjects did not differ on the mental rotation task, suggesting that this cognitive function was unimpaired by BPPV. The side of impairment was strongly related to the side of perceived bias in visual vertical determined by BPPV subjects, indicating the relationship between otolith unloading and simultaneous canal loading and spatial orientation perception.

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PP023

Bilateral Vestibulopathy

**EFFECT OF NOISY GALVANIC VESTIBULAR STIMULATION ON GAIT PERFORMANCE IN PATIENTS WITH BILATERAL VESTIBULOPATHY.**

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**Objective:** To examine the effect of noisy galvanic vestibular stimulation (GVS) on gait performance in patients with bilateral vestibulopathy (BV).

**Methods:** 10 m walk test was performed in 10 BV patients with white noise GVS with an amplitude ranging from 0 to 1,000  $\mu$ A. We measured 3 parameters: the gait speed, the step length and the gait cycle, using a triaxial accelerometer device.

**Results:** The gait speed was significantly increased at 200–1000  $\mu$ A GVS than that without stimuli ( $p < 0.05$ ). The step length was significantly increased at 700–1000  $\mu$ A GVS than that without stimuli ( $p < 0.05$ ). On the other hand, the gait cycle was significantly decreased at 500  $\mu$ A GVS than that without stimuli ( $p < 0.05$ ).

**Conclusions:** Noisy GVS is effective in increasing the gait speed, lengthening the step length and shortening the gait cycle in BV patients.

PP024

Bilateral Vestibulopathy

**DELAYED VESTIBULAR IMPAIRMENTS AFTER HEAT EXPOSURE**

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Even though dizziness is a common symptom of heat illness, comprehensive evaluation of the vestibular function has not been available in this potentially life threatening disorder. Three patients developed vertigo a week after heat exposure. Evaluation showed bilateral impairments of the vestibulo-ocular reflex during head impulses and the signs of vestibulocerebellar dysfunction that included spontaneous downbeat nystagmus, gaze-evoked nystagmus, and positional downbeat nystagmus. Exposure to heat may give rise to delayed vestibular impairments by damaging the vestibulocerebellum.

PP025

Bilateral Vestibulopathy

**SELECTIVE IMPAIRMENT OF HORIZONTAL VESTIBULO-OCULAR REFLEXES IN ACUTE WERNICKE'S ENCEPHALOPATHY.**

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Acute Wernicke's encephalopathy (AWE) is a medical emergency. We report 2 AWE patients with a unique pattern of vestibular loss: selective, bilateral, symmetrical impairment only of horizontal and not of vertical vestibulo-ocular reflexes on impulsive testing.

A 55 year-old alcoholic woman had been uncommunicative and off-balance for a week. She had almost total loss of horizontal eye movement including VOR on impulsive testing but normal vertical saccades, VOR, normal convergence. With scleral-search-coils there was bidirectional horizontal gaze-evoked nystagmus. Impulsive VOR gain was only 0.1 (normal > 0.9) horizontally but 0.95 vertically. MRI showed subtle high signal in the dorsal midbrain. A 64-year-old man presented with abdominal pain and vomiting for a month. He did not drink alcohol. He was given 5 days total parenteral nutrition containing a total of only 17.5 mg thiamine. After a week he complained of vertigo and imbalance and was confused. He had bilaterally limited horizontal gaze with slow horizontal saccades, bilateral gaze-evoked nystagmus but intact vertical gaze and convergence. The clinical head impulse test was symmetrically abnormal to the left/right with slow overt catch-up saccades, but was normal up/down, findings confirmed on the video Head-Impulse Test. MRI showed increased signal in the hypothalamus, medial thalamus and dorsal midbrain. Thiamine 600 mg/day was given intravenously. Gaze palsy resolved in a week. After 4 months his video Head-Impulse Test still showed severe selective bilateral impairment of the horizontal VOR.

This unique pattern of vestibular loss with Wernicke's encephalopathy can be diagnosed and monitored with the video Head-Impulse-Test.

PP026

Central Vestibular Disorders

#### **HEAD SHAKING NYSTAGMUS CURED BY LATERAL CANAL OCCLUSION**

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Bronstein et al. reported a new syndrome, Head-jolting nystagmus, cured by lateral semicircular canal occlusion on the quick-phase side. We confirm their observation in a 57-years old man with vertigo, induced only by head-shaking. On examination the only abnormalities were vigorous left-beating horizontal nystagmus (peak slow phase-velocity ~60 deg/s in darkness) with malaise and nausea lasting up to 60 sec after head-shaking and tilting of head and trunk en-bloc 20–30 deg right. Vestibular tests (calorics, video head-impulses, VEMPs), audiometry, brain MRI, CT temporal bones were all normal. Over 4 years we treated him with many different medications to no avail. Eventually just 3–4 head-shakes would set off the left-beating nystagmus and make him nauseated. Repeat video HIT showed a minor but definite impairment of left lateral canal function. Repeat VEMPs were still normal. We recommended a left lateral semicircular canal occlusion. A month after the surgery he said he felt better than he had for years. Head-shaking no longer produced any vertigo, nausea or malaise and only about 5 seconds of right-beating nystagmus with a peak velocity of only 7 deg/s. Head-impulse testing showed that the left lateral canal was inactivated, but by only about 50%; the vertical canals were still normal but he had lost about 50dB hearing at 4–8 kHz. Other neuro-otologists must have seen similar cases and it will interesting to follow how the phenomenology and causation this unusual syndrome is further refined.

PP027

Central Vestibular Disorders

#### **VESTIBULARLY EVOKED VISUAL HALLUCINATIONS IN CORTICAL BLINDNESS**

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Previous work shows that caloric vestibular stimulations evoke elementary visual hallucinations in healthy humans. Surprisingly the present study reveals that the same stimulations can evoke visual hallucinations in a patient with

cortical blindness but they are with essentially different characteristics. They are complex and from daily life. However they do not include other senses besides vision. We conclude that in condition of pathology vestibular-visual interaction may stimulate hallucinogenic subcortical or undamaged cortical structures and mechanisms that can generate visual images only.

PP029

Central Vestibular Disorders

### COMPARISON OF OTO-NEUROLOGICAL FINDINGS BETWEEN SPINOCEREBELLAR ATAXIA TYPES 31 AND 6

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**Introduction:** Spinocerebellar ataxia type 31 (SCA31) is an autosomal dominant type of pure cerebellar ataxia, that was established after the focal gene was identified in 2009. Most patients with SCA31 are found in Japan, and its clinical neurological features are similar to those of spinocerebellar ataxia type 6 (SCA6). However, very little is known about the oto-neurological findings of SCA31. The present study compares the oto-neurological findings of SCA31 and SCA6.

**Materials and Methods:** We retrospectively analyzed the oto-neurological findings of 16 patients (male,  $n = 7$ ; female,  $n = 9$ ) with SCA31 that was definitively diagnosed from gene information retrieval at the Department of Neurology, Tokyo Metropolitan Neurological Hospital. An age-matched control group comprised 24 patients with SCA6 (male,  $n = 12$ ; female,  $n = 12$ ) that was also genetically confirmed at our hospital. Abnormal eye movements such as gaze nystagmus, positional and positioning nystagmus, smooth pursuit, saccades, optokinetic nystagmus (OKN), visual fixation suppression (VS), and the pure tone audiogram (PTA) threshold were analyzed in both groups.

**Results:** Gaze nystagmus, rebound nystagmus, saccadic pursuit, dysmetric saccades, impaired OKN and VS, and down beat nystagmus were identified in both groups. The degree of OKN and VS impairment was not severe among the patients with SCA31 and less had positional and positioning nystagmus than those with SCA6. The PTA threshold did not significantly differ between the SCA31 and SCA6 groups.

**Conclusions:** Detailed eye-movement evaluation would facilitate a clinical diagnosis before a differential diagnosis of SCA31 and SCA6 using gene analysis.

PP030

Central Vestibular Disorders

### POST-STROKE DIZZINESS AND VERTIGO: NATURAL COURSE AND PREDICTORS FOR POOR PROGNOSIS

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**Background & Objects:** Dizziness and vertigo are known warning symptoms of stroke involving intratentorial structures, a prognosis of post-stroke dizziness and vertigo remains unknown. In this study, we investigated post-stroke dizziness and vertigo in terms of their temporal characteristics and poor prognostic factors.

**Methods:** We retrospectively analyzed dizziness and vertigo using dizziness handicap inventory (DHI), UCLA Dizziness Questionnaire (UCLA-DQ), and short-form vertigo symptom scale (sf-VSS) reported by 37 consecutive patients with acute intratentorial stroke from January 2014 to December 2015. The questionnaires were taken at 1 week, 1 month, 3 months, 6 months, and 12 months after onset of stroke. The factors for poor prognosis of post-stroke dizziness and vertigo were analyzed by generalized linear mixed models (GLMM).

**Results:** DHI, UCLA-DQ, and sf-VSS scores were 39.1, 14.9, and 10.7 at 1 week, 21.4, 15.6, and 10.9 at 3 months, 17.6, 9.4, and 3.4 at 12 months. The post-stroke dizziness and vertigo significantly decreased along time and patients

with mRS > 1 was independent poor prognostic factor for post-stroke dizziness and vertigo. Conclusion: The present study suggested that a majority of patients with infratentorial stroke lesion was suffered from post-stroke dizziness and vertigo. Modified Ranke scale more than 1 point at 1 week after onset of symptoms is a most reliable predictor for poor outcome.

PP031

Central Vestibular Disorders

### CHARACTERISTICS AND MECHANISM OF PERVERTED HEAD-SHAKING NYSTAGMUS IN CENTRAL LESIONS

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**Objective:** Perverted downbeat head-shaking nystagmus (pdHSN) has been considered a sign of central pathology. Several hypotheses have been advanced as the mechanisms of pdHSN, but none of them has been validated. This study aimed to elucidate the mechanism of pdHSN.

**Methods:** Eighteen patients with pdHSN due to central lesions were subjected to analyses of their oculographic characteristics. The peak velocity, temporal features including the duration and time constant (TC), rotational axis of pdHSN were analyzed. To determine the most relevant mechanism of pdHSN, we compared the TCs of pdHSN with those of downbeat nystagmus after vertical head-shaking, and with the TCs of horizontal head-shaking nystagmus (HSN). We also compared the TCs of horizontal HSN and pdHSN between the upright and supine positions.

**Results:** The duration of pdHSN in the upright position ranged from 14 to 25 seconds and the mean TC was 5.2 seconds. The rotational vectors of pdHSN were mostly aligned between the anterior semicircular canals. The TC of downbeat nystagmus after vertical head-shaking was similar to that of pdHSN. In contrast, the TC of horizontal HSN (10.9 seconds) was significantly larger than that of pdHSN. Finally, the TCs of pdHSN and horizontal HSN differ between the upright and supine positions in each patient tested.

**Conclusion:** The characteristics of TCs of HSN in our patients with central lesions suggest that pdHSN is due to enhanced activities of the central anterior canal pathway, probably due to disinhibition.

PP032

Central Vestibular Disorders

### NEURO-OTOLOGICAL MANIFESTATIONS OF SUBARACHNOID AND VENTRICULAR NEUROCYTICERCOSUS

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**Introduction:** The neuro-otological manifestations associated with neurocysticercosis (NCC) have not been thoroughly described although they are frequently mentioned when parasites are located extraparenchymally although such symptoms generally improve with treatment. In this study we describe the characteristics and frequencies of neuro-otological manifestations associated with subarachnoid neurocysticercosis of the base and the fourth ventricle and evaluate their relationship to the location of the parasites as well as the intensity of the inflammation.

**Materials and Methods:** A cross-sectional descriptive study including 43 consecutive outpatients with the diagnosis of extraparenchymal NCC was conducted. Each patient's battery tests included a neuro-otologic examination, audiometry, electronystagmography and MRI with FIESTA sequences.

**Results:** 15 women (34.9%) and 28 men (65.1%) were included; with an average of 51 years of age (42–59). 41 of them (95.3%) reported neuro-otologic symptoms: hearing loss (53.1%), tinnitus (70.7%), dizziness (75.6%) and vertigo (31.7%). Audiometry studies were abnormal in 29.7% while electronystagmography was altered in 19.3% of patients. Parasites were located mostly in the cerebellopontine cistern (79.1%). Location in the fourth ventricle was associated with the presence of dizziness ( $P = 0.04$ ) while the presence of inflammatory changes (arachnoiditis or ependymitis) was associated with the presence of tinnitus ( $P = 0.006$ ).

**Conclusions:** This study describes the neuro-otologic alterations associated with NCC. The results show that patients symptoms with extraparenchymal NCC are common, some of them being promoted by the inflammatory process. These results should lead to consider the neuro-otologic evaluation of these patients in order to detect any anomaly and promptly induce treatment.

PP033

Central Vestibular Disorders

### STEREOTACTIC RADIOSURGERY FOR ACOUSTIC NEUROMAS- A SINGAPORE EXPERIENCE

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**Objective:** We report outcomes from a 7-year cohort of patients with acoustic neuromas (AN) treated using a stereotactic radiosurgery system with both single session as well as hypofractionated regimens.

**Method:** A retrospective database was used, with review of case notes and imaging reports and scans. Treatment was administered as a single 13Gy or 25Gy in 5 sessions. Tumour response was assessed using RECIST criteria, and hearing recorded with Gardner-Robertson Scale, other toxicities were based on physical examination and history. Progression free survival was estimated with the Kaplan-Meier method.

**Results:** 77 patients were analysed, with median follow up of 40.7 months. 29 patients had prior surgery to remove the tumour. Median size for single fraction and hypo-fractionated regimes were 1.18 and 3.12cc respectively. Out of 46 patients who received a single fraction, 16 (34.8%) were Koos 3 or 4. Out of 31 who received hypo-fractionated treatments, 20 (64.5%) were Koos stage 3 or 4. One subject had symptomatic increase in size of AN, was treated conservatively and had subsequent MRI showing stable disease. Progression-free survival was 98.7%. Another subject with a larger than median tumour (7.17cc) developed symptomatic oedema requiring a ventriculo-peritoneal shunt insertion. Among those with serviceable hearing pre-RS, 72.7% retained useful hearing with mean pure tone average decline of 20.1dB. Other toxicities include 3 (3.9%) patients who developed worsening facial nerve dysfunction, 2 (2.6%) had worsening trigeminal nerve dysfunction and 3 (3.9%) reported worsening or new disequilibrium.

**Conclusion:** Based on our local experience, RS is an effective modality for small AN, with good control rates and minimal toxicities.

PP034

Central Vestibular Disorders

### CENTRAL POSITIONAL NYSTAGMUS: A SYSTEMATIC LITERATURE REVIEW

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**Objectives:** To provide the first systematic review of the clinical features and radiological findings of central positional nystagmus (CPN) and identify salient characteristics that differentiate central from peripheral positional nystagmus.

**Methods:** Systematic literature search according to the Preferred Reporting items for Systematic Reviews and Meta-analysis (PRISMA). This review included studies that reported CPN upon positional testing.

**Results:** A total of 76 patients from 24 studies met the PICOS criteria for inclusion. An atypical direction of nystagmus was reported in 97.4% patients during Dix-Hallpike and 44.4% upon supine roll testing. Overall, five types

of CPN were identified: positional horizontal (35.3%), positional down-beating (29.3%), pure torsional (2.3%), up-beating (2.3%), and a combination of the four profiles (30.9%).

CPN was paroxysmal in 58.2% and had a latency < 5 seconds upon positioning in 95.2% patients in which it was reported. Vertigo was reportedly present in 60.5% patients, and 64.5% complained of other neurological symptoms, such as motor weakness, headache and unsteadiness of gait. Radiologically, in 69.7% there was mention of cerebellar involvement. 13.6% were reported to have lesions involving the IVth ventricle, 9.4% had isolated nodular lesions and 9.2% had isolated brainstem lesions.

**Conclusions:** Central positional nystagmus represents a posterior fossa disorder of the vestibular system, and its clinical diagnosis remains a challenge for acute medicine and neurology. With an increasing awareness of this entity and its underlying mechanisms, we may see a change in the estimated prevalence of central positional vertigo, and improved clinical markers to promptly identify its frequently sinister underlying causes.

PP035

Clinical Testing for Vestibular Function

**STANDARD VS. NOSE ELECTRODE PLACEMENT FOR MEASURING OVEMPS: TEST-RETEST RELIABILITY & PRELIMINARY PATIENT RESULTS**

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**Objectives:** The ocular vestibular evoked myogenic potential (oVEMP) technique is a relatively new addition to the vestibular test battery, probing utricular function and superior vestibular nerve integrity. This study compared two electrode placements ('standard' versus 'nose') for measuring oVEMPs elicited by air-conducted 500 Hz tone bursts. The test-retest reliability of both positions was evaluated and additionally both electrode placements were applied on a group of vestibular patients.

**Subjects & design:** A prospective study design was applied. Nineteen healthy volunteers (range of 20-25 years) participated in the first part and were retested after one week for evaluation of the test-retest reliability. Eleven patients (range of 41-74 years) with a variety of vestibular pathologies were tested once.

**Results & conclusion:** The nose electrode placement resulted in significantly larger response amplitudes ( $p < 0.001$ ), shorter n10 ( $p = 0.001$ ) and p15 ( $p < 0.001$ ) latencies and smaller 95% prediction intervals for the Inter-Ocular Ratio (IOR) ([-67.90, 67.90] for the standard position versus [-32.15, 32.15] for the nose position). Furthermore, an excellent amplitude and IOR test-retest reliability was observed with the nose configuration, as shown by the intraclass correlation coefficient (ICC), the coefficient of variation of the method error (CVME) and the minimal detectable differences (MDD). Our preliminary patient data demonstrated a trend towards earlier detection of abnormalities using the nose position compared to the standard position. Consequently, the nose electrode position may be promising for clinical use after further systematic patient verification.

PP036

Clinical Testing for Vestibular Function

**VESTIBULAR EVOKED MYOGENIC POTENTIALS IN PATIENTS WITH MULTIPLE SCLEROSIS**

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**Introduction:** Multiple sclerosis (MS) is an inflammatory, demyelinating, and neurodegenerative disorder of the central nervous system (CNS) from unknown etiology. As many locations within the CNS may be affected, the clinical presentation of individuals with MS is extremely variable. The aim of this work was to investigate if the assessment of c-VEMPS's helps to identify vestibulospinal abnormalities in patients with MS.

**Methods:** Fourteen MS patients were referred and 30 healthy subjects were submitted to a clinical history and physical examination. During each recording session, in seated position, the subject was instructed to rotate the head towards the contra-lateral side of the tested ear to keep the SCM muscle under tension. Tone burst (1 kHz, 118 dBnHL, rise-fall 1 ms, plateau 2 ms) presented through a supra-aural earphone.

**Results:** control group provided normative data P13:13.66 ± 1.04 ms, N23:23.23 ± 1.90 ms, amplitude asymmetry index was set as < 26.4 %. From the study group, only one subject presented normal responses bilaterally (7.1%). All other 13 showed abnormal responses (92.8 %). 8 patients (57.1%) showed increased P13, N23 and P13-N23 inter peak latencies. 5 patients (35.7%) showed an asymmetry greater than 26.4%. In 4 patients (28.5%) no response was obtained on one or both sides.

**Conclusion:** abnormal c-VEMP responses may be observed in MS patient and has to be considered as a relevant clinical tool to assess the vestibulo-spinal (vestibulo-collic) pathway in MS.

PP037

Clinical Testing for Vestibular Function

### **DOES COMPUTERIZED DYNAMIC POSTUROGRAPHY DETECT MEASURED C & OVEMP ABNORMALITIES**

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Computerized Dynamic Posturography (Equitest) is an internationally recognized method of detecting excessive static sway. This is a nonspecific measure of abnormal sway due to mostly vestibular and neurological diseases. Computerized Dynamic Posturography measures vestibulospinal function. Previous study by the authors attempting to show that abnormal C and OVEMPs were associated with abnormal Computerized Dynamic Posturography were, at best, equivocal. The present study of 200 patients assesses Computerized Dynamic Posturography as well as C and OVEMPs and shows conclusively that Computerized Dynamic Posturography abnormalities are independent of and not associated with C or OVEMP abnormalities. We conclude that this is probably because C and OVEMPs assess head and eye movement which in terms of function is independent of vestibulospinal function as it is crucial to be able to move the head completely independently of body movement for maintenance of balance while looking around for predator threat while in motion.

The exact function of VEMPs at present is unclear. Assessment of soleus VEMPs to see whether they are associated with Computerized Dynamic Posturography sway may answer the question of whether these responses are related to vestibular function. The other possibility is that they represent an active response of the balance organs aimed at suppressing vibratory effects of audition while speaking via the external auditory canal or via sound conduction through the skull.

PP038

Clinical Testing for Vestibular Function

### **THE STUDY OF VESTIBULAR AUTOROTATION TEST IN PERIPHERAL VESTIBULAR DISORDERS**

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**Objective:** This study analyze the VAT results of patients with peripheral vestibular disorders, to provide reliable and valid basis for the vestibular functional assessment and rehabilitation of the patients in clinical.

**Methods:** Two hundred and forty seven patients with peripheral vestibular disorders (male 104, female 143) were enrolled in this study, include sudden deafness with vertigo 169, hunt's Syndrome 42, and 36 patients with vestibular neuritis. All the patients were subjected to the Vestibular Autorotation Test (VAT). There were five indicators include

horizontal and vertical eye movement gain, phase and asymmetry of VAT. We assessed the test positive when one or more parameters abnormal above the five indicators, the gain and phase positive when one or more gain and phase abnormal above the horizontal and vertical indicators. Statistical analysis by SPSS 16.0, used the chi-square test,  $P < 0.05$  was considered statistically significant.

**Results:** 1. VAT positive rate 230 (93.1%), gain 168 (68%), phase 196 (79.4%), asymmetry 154 (62.3%). 2. The horizontal high-gain and vertical high-gain were 7 (3%) and 13 (5%); the horizontal low-gain and vertical low-gain were 137 (55.5%) and 11 (4.5%) cases; the high-gain were 20 (8%), the low-gain were 148 (59.9%), they had the statistically significant differences,  $P < 0.05$ .

**Conclusion:** The VAT gain indicators in peripheral vestibular disorders patients mainly showed low-gain, it related to the etiology and ambit of vestibular trauma in the patients; the VAT gain indicators is beneficial for the qualitative assessment, and analyze etiology of vestibular system damage in patients with peripheral vestibular disorders.

Keywords: Peripheral vestibular disorders, Vestibular autorotation test, Vestibular function, Frequency

PP039

Clinical Testing for Vestibular Function

### **POSTURAL INSTABILITY IN SENIORS: PERIPHERAL OR CENTRAL VESTIBULAR DYSFUNCTION?**

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Postural instability is common in seniors and can lead to falls which seniors are a major problem for Public Health. This is caused by multiple factors including: musculoskeletal, visual, cognition, vestibular.

The present study concerns the effect of age on the vestibular peripheral receptors function and on the perception of rotation from horizontal canal inputs (central vestibular processing). At the peripheral level, the horizontal canal function was assessed using caloric test and vHIT. Otolith function was assessed using VEMPs recorded at cervical level (sacculo-spinal pathways) and at ocular level (utriculo-ocular pathways). At the central level, perception of motion from vestibular horizontal canal inputs was studied after warm water caloric stimulation using a perceptual score. Postural equilibrium was assessed with the Equitest machine and also with a new system developed using a Wii Balance Board, a foam rubber pad and a virtual reality headset (Oculus Rift DK2).

Results showed decreased ocular responses induced by caloric stimulation after 70 years of age but healthy horizontal gain of the vestibulo-ocular reflex assessed by video-head impulse testing. The otolithic (saccular and utricular) function is impaired with age. Perception of motion induced by caloric stimulation allowed to show that some seniors are unable to feel the induced rotatory vertigo even with normal ocular responses.

Postural instability and falls in seniors may result from central vestibular impairment. A prospective study is needed to determine whether the increase perceptual threshold of rotation could be a good predictor of fall risk in seniors.

PP040

Clinical Testing for Vestibular Function

### **QUANTITATIVE ANALYSIS OF NYSTAGMUS BY THE ORIGINAL REAL-TIME VIDEO-OCULOGRAPHY AND IMAGE FILING SYSTEM, YVOG.**

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It is essential to use an infrared CCD camera in clinical examination of the vestibular system. Devices are currently available that can quite accurately record human eye movements, based on the principle of video-oculography (VOG). We have devised an original VOG (HI-VOG) system using a commercialized infrared CCD camera, a per-

sonal computer and public domain software program (ImageJ) for data analysis. We revised the VOG and image filing system for real-time quantitative analysis of nystagmus, yVOG.

The video image from the infrared CCD camera was captured at 30 frames per second at a resolution of 640\*480 p1. For analysis of the horizontal and vertical components, the X-Y center of the pupil was calculated using the original macro. For analysis of torsional components, the whole iris pattern, which was rotated by 0.1 degree, was overlaid with the same area of the next iris pattern, and the angle at which both iris patterns showed the greatest match was calculated.

For quantitative analysis, the slow phase velocity of each occurrence of nystagmus and the average value of the slow phase velocity were analyzed automatically. Using the revised VOG system, it was possible to perform real-time quantitative analysis of nystagmus parameters from video images recorded with an infrared CCD camera.

This work was supported by R & D Promotion Subsidy System (Yamaguchi Prefecture Government) and JSPS KAKENHI.

PP041

Clinical Testing for Vestibular Function

### **CERVICO- AND VESTIBULO-OCULAR REFLEX INTERACTIONS REVEALED WITH THE VIDEO HEAD IMPULSE TEST (vHIT)**

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The cervico-ocular reflex (COR) and the vestibulo-ocular reflex (VOR) are reported to interact with each other in both compensatory and anti-compensatory ways. To evaluate the interaction between the COR and VOR, the neck was twisted to the left or right, while observing VOR gain during the video head impulse test (vHIT).

Subjects included 15 healthy controls and 29 patients with canal paresis (CP) on the caloric test. Patients were divided into 2 groups: 15 patients having  $20\% \leq CP < 50\%$  and 14 patients having  $CP \geq 50\%$ . vHIT was performed in the horizontal semicircular canal plane with the head always facing the front and the neck twisted to the left or right. VOR gain change was regarded as positive when the gain increased or decreased by  $\geq 0.1$ .

No VOR gain change was observed in controls except for 1 case. In the  $20\% \leq CP < 50\%$  group, 5 patients had increased VOR gain with the neck twisted to the affected side, 2 patients had increased gain with the neck twisted to the unaffected side, while no change was observed in 8 patients. In the  $CP \geq 50\%$  group, 5 patients had increased VOR gain with the neck twisted to the affected side, 5 patients had increased gain with the neck twisted to both sides, 1 patient had decreased gain with the neck twisted to the affected side. No change was observed in 3 patients. We conclude that the interaction of the COR and VOR was more apparent in patients with CP than in healthy individuals.

PP042

Clinical Testing for Vestibular Function

### **VIDEO HEAD IMPULSE TEST IN THE PATIENTS WITH INNER EAR MALFORMATIONS**

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Many studies have been reported about the association between morphology of inner ear malformations and hearing. However, the study of vestibular function and its morphology is very much limited. The objective of this study is to evaluate vestibular function in the patients with inner ear malformations using video Head Impulse test (vHIT).

This is a retrospective study of 234 cases to whom we have conducted vHIT and imaging study.

Eleven patients (16 ears) were found to have inner ear malformations in imaging study. Large vestibular aqueducts, Michel deformity, hypoplasia of the semicircular canals and/or vestibule, and cochlear nerve aplasia were observed. In all cases, we could perform horizontal vHIT and, in some cases, we also performed vertical vHIT (RALP/LARP).

As a result, some interesting findings were observed in the present study. Malformed sites in the patients of inner ear malformations vary in each case. Therefore, caloric test is limited to evaluate the vestibular function in detail. We recommend vHIT for the patients with inner ear malformations. Because, vHIT can test physiological condition, and can evaluate not only horizontal, but also vertical canal function.

PP043

Clinical Testing for Vestibular Function

### CONTRIBUTION OF OTOLITH DYSFUNCTION IN POSTURAL INSTABILITY IN PATIENTS WITH DIZZINESS

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**Background and Objectives:** Postural stability relies on multisensory input signals including those from the vestibular system. Although the effect of disorders of the semicircular canals on posture control has been extensively studied, few studies have focused on otolith dysfunction. The purpose of this study was to investigate the effect of otolith dysfunction measured using cervical vestibular evoked myogenic potential (cVEMP) and subjective visual vertical (SVV) affect postural stability in patients presenting with dizziness.

**Methods:** A retrospective review of consecutive 276 patients presenting with dizziness was performed. Comprehensive vestibular function tests included videonystagmography, cVEMP, SVV, and self-report measures of subjective dizziness handicap (Dizziness Handicap Inventory, DHI). Postural stability was measured using the Sensory Organization Test (SOT) of the computerized dynamic posturography (CDP). We compared equilibrium score (ES) and DHI scores with results of vestibular function tests.

**Results:** Patients with confirmed canal paresis had increased DHI total scores and decreased ES compared to those without canal paresis. In patients with canal paresis, concurrent abnormal VEMP and/or SVV results did not affect the DHI or ES ( $p > 0.05$ ). Interestingly, in patients without canal paresis, presence of abnormal VEMP and/or SVV results significantly increased DHI scores and decreased ES ( $p < 0.001$ ).

**Conclusions:** Our findings suggest that otolith dysfunction might impact posture control and exacerbated subjective symptoms in patients with dizziness. However, additional effects appear less prominent in patients with canal paresis.

PP044

Clinical Testing for Vestibular Function

### RESULTS OF VIDEO HEAD IMPULSE TEST AND CALORIC TEST IN VESTIBULAR NEURITIS AND LABYRINTHITIS.

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**Purpose:** To find a correlation between the degree of canal paresis (CP) in caloric test and vHIT result, we reviewed the caloric test and vHIT in vestibular neuritis (VN) and labyrinthitis patients.

**Method:** We reviewed the data of 30 patients who diagnosed VN or labyrinthitis. All patients had sudden onset of dizziness with or without sudden hearing loss and showed vestibulopathy in caloric test. The mean age of the patients was 54.4 years, and there were 18 males and 12 females. In this study, we categorized the CP values of the caloric test into 3 levels: 1) 26 ~ 50%, 2) 51 ~ 75% and 3) 76 ~ 100%. Then we compared the result of vHIT and CP values of each level. The definition of abnormal vHIT was normal gain with catch up saccades (covert or overt) and low gain ( $< 0.6$ ) either with or without saccades.

**Result:** Among the 30 patients who had abnormal canal paresis ( $\geq 26\%$ ), eighteen patients (60%) showed abnormal vHIT. Abnormality rates of vHIT were 27% (3/11), 75% (9/12), and 86% (6/7) in CP = 26~50%, CP = 51~75%, and CP = 76~100% group, respectively.

**Conclusion:** In this research, we observed a positive correlation between the CP values and the likelihood of showing abnormal vHIT in the patients either with VN or labyrinthitis.

PP045

Clinical Testing for Vestibular Function

**DIAGNOSTIC VALUE OF VIDEO HEAD IMPULSE TEST IN UNILATERAL VESTIBULAR HYPOFUNCTION.**

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**Objective:** Although there are many tests for evaluate the vestibular hypofunction, caloric test is used as most reliable test. Video Head impulse test(vHIT) is one of important test to detect the unilateral vestibular hypofunction. vHIT is more sensitive and specific than conventional bed side head impulse test(bHIT). The aim of this study is to evaluate the diagnostic value of vHIT in unilateral vestibular hypofunction patients.

**Methods:** We measured patients exhibiting vertigo or dizziness with bithermal caloric irrigation, v-HIT, b-HIT, Head shaking nystagmus(HSN) and spontaneous nystagmus(SN). We considered unilateral vestibular hypofunction as whose caloric test of more than 25% unilateral weakness. And result of vHIT, bHIT, SN, HSN was evaluated according to the result of caloric test.

**Results:** 167 patients with vertigo and dizziness at our hospital was enrolled. Among them 54 patients showed pathological caloric test of more than 25% unilateral weakness. Out of these patients, 33% had pathologic vHIT, 27% showed catch up saccade in bHIT and 42% in HSN. Patients with vestibular hypofunction and normal vHIT, showed relatively younger age and longer symptom duration.

**Conclusion:** Only 33% showed the pathological vHIT in patients with vestibular hypofunction. Patient age and duration of symptom may affect result of vHIT.

PP046

Clinical Testing for Vestibular Function

**RESULTS OF VIDEO HEAD IMPULSE AND CALORIC TESTS IN “DEFINITE” MÉNIÈRE’S DISEASE**

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**Background:** vHIT is used for examining the high acceleration VOR function in peripheral vestibular disorders.

**Purpose:** The aim of this study to investigate that how frequency video head impulse test (vHIT) is positive in MD compared with caloric test, and to speculate the meaning of vHIT in natural course of MD.

**Methods:** This study reviewed the data of 40 patients (20 females and 20 males, mean age 55.5 years) who met the AAO-HNS criteria for “definite” MD and who had both caloric and vHIT testing. Definition of abnormal vHIT was normal gain with catch up saccades (covert or overt), and low gain (< 0.6) either with or without saccades.

**Results:** Total 21 patients (52.5%) showed caloric asymmetries among 40 “definite” MD patients. Only two (9.5%) patients showed abnormal results of vHIT in patients who had abnormal result in caloric test. The abnormal rate of vHIT was significant lower in definite MD compared with vestibular neuritis (60%).

**Conclusion:** In the “definite” MD, positive rate of abnormal vHIT was very low compared to other vestibular disease. This meant that in the natural course of MD, the hair cells for high acceleration VOR is saved.

PP047

Clinical Testing for Vestibular Function

**SIMULTANEOUS RECORDINGS OF CERVICAL AND OCULAR VEMPS INCREASE ITS CLINICAL APPLICABILITY**

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**Objectives:** To lower the threshold for clinical application by reducing the testing time for recording vestibular-evoked myogenic potentials (VEMPs), we evaluated whether a simultaneous recording of ocular and cervical VEMPs after unilateral or bilateral stimulation can be achieved without a loss in diagnostic sensitivity.

**Methods:** In 30 healthy participants, unilateral simultaneous cVEMP and oVEMP recordings in each side during monaural stimulation (air-conducted sound, 500 Hz tone bursts, 100 nHL), and bilateral simultaneous recordings of each VEMP while binaural stimulation were compared to conventional method of sequential recording each VEMPs on each side at a time. Mean latencies of p13 and n10, peak-to-peak amplitudes, the asymmetry ratios (AR) and thresholds of cVEMP and oVEMP, and the recording time of each method were measured.

**Results:** Both unilateral and bilateral simultaneous recordings effectively reduced the time required to test VEMPs by about 70% versus conventional separate recordings ( $p < 0.001$ ). The unilateral simultaneous cVEMP and oVEMP recordings during monaural stimulation produced no significant difference compared to the conventional recordings except for an increase in oVEMP amplitude (142%). In contrast, bilateral simultaneous recording of each VEMP during binaural stimulation resulted in significantly reduced amplitudes (28.4%) and increased thresholds for cVEMPs.

**Conclusions:** Unilateral simultaneous recording of cVEMPs and oVEMPs during monaural stimulation was comparable to the conventional sequential recording while reducing the time for whole recording of both VEMPs and seems to represent a more distinctive basis rather than simultaneous bilateral recording of each VEMP during binaural stimulation.

PP048

Clinical Testing for Vestibular Function

### UTRICULOPATHY FOLLOWED BY ANTERIOR SEMICIRCULAR CANAL BENIGN PAROXYSMAL POSITIONAL VERTIGO

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**Purpose:** To our knowledge, the acute isolated utriculopathy is an uncertain entity.

**Method:** We report a dizzy patient with isolated utricular dysfunction followed by anterior semicircular canal benign paroxysmal positional vertigo (BPPV).

**Result:** A 24-year-old patient presented with acute dizziness and imbalance for several hours. Intermittent ear fullness and tinnitus were accompanied in the both ear. There was no abnormal head tilt. Ictal examination showed right horizontal nystagmus without fixation. This nystagmus was not augmented and suppressed by any induced maneuvers such as gaze, hyperventilation, head-shaking and position change. Head impulse test was normal. The caloric response was symmetric. Ocular/Cervical evoked myogenic potential to air stimuli was normal (VEMP). Subjective visual vertical was normal. Pure tone audiometry was normal. However, the ocular VEMP response to bone conduction was decreased in the left ear (amplitude asymmetry index ratio; 23.1%). Fundus photo demonstrated leftward ocular torsion (4.8° intorsion OD, 16.0° extorsion OS). Six days later, he complained positional vertigo, aggravated at head bending and leftward head turning in the supine position. Neurotological examination demonstrated counter-clockwise torsional downbeat nystagmus compatible with typical BPPV originating from left anterior semicircular canal. Brain MRI including internal auditory canal view was normal.

**Conclusion:** Otolithic vertigo could present with acute dizziness and imbalance. And the anterior semicircular canal BPPV could follow the acute utricular dysfunction.

PP049

Clinical Testing for Vestibular Function

**AGING OF VESTIBULO-OCULAR REFLEX (VOR)****Dusan PAVLOVIC***Department of Neuro-otology, Hearing And Balance Center Belgrade, Serbia*

**Intro:** Video Head Impulse Test (VHIT) is relatively new diagnostic method for measuring vestibulo-ocular reflex (VOR) gain at high frequency, and since few years ago it's also available to measure VOR gain not just in horizontal but in a vertical planes also. VOR gain is influenced with stimulus intensity, but we lack of information how aging can influence VHIT results.

**Aim:** to investigate if VOR gain in horizontal or vertical canals reduces with age.

**Method:** To measure VOR gain in all six canals with Synapsys VHIT in 96 healthy subjects, divided in three age groups: 20–39 years (33 patients), 40–59 years (30 patients) and > 60 years (33 patients).

**Results:** VOR gains of posterior canals were significantly lower in the oldest group. There was no difference in VOR gain between groups for anterior and horizontal canals.

**Conclusions:** VOR gain reduces with age only in posterior canals. For posterior canals different cut-off values of VOR gain should be used for older patients.

PP050

Clinical Testing for Vestibular Function

**INFLUENCE OF ACOUSTIC AND MECHANICAL VEMP STIMULI ON BALANCE AND GAIT.****PRELIMINARY RESULTS****Alejo SUAREZ**<sup>1</sup>, Maria Jose AROCENA<sup>1</sup>, Rafael ALONSO<sup>2</sup><sup>1</sup>*Department of Otoneurologia, Laboratorio De Otoneurologia, Uruguay*<sup>2</sup>*Department of Metodos Cuantitativos, Facultad De Medicina, Uruguay*

Since the description of muscle responses from vestibular origin, vestibular evoked myogenic potentials (VEMP) have become a popular way to characterize clinical otolith physiology and pathophysiology and to better evaluate peripheral vestibular disorders. Air conducted sound and head vibration stimulation evoke electromyographic changes either on ipsilateral sternocleidomastoid (cVEMP) or contralateral inferior oblique and inferior rectus extraocular muscles (oVEMP)(Rosengren and Kingma, 2013), which enables the analysis of utricular and saccular function.

The aim of this study, is to evaluate if routinely acoustical and mechanical VEMP stimuli used for clinical testing, affects balance. We studied a group of 12 healthy subjects, evaluating vestibular function by means of vHIT, cVEMP, oVEMP and subjective visual vertical (bucket test). Balance was evaluated using BlanceSens (BioSensics, Cambridge, MA), measuring sway area, sway velocity and medio-lateral displacement of the center of mass. Also gait was evaluated using LEGSys (BioSensics, Cambridge, MA), measuring cadence and stride length while walking on a treadmill. Balance was evaluated in basal conditions (eyes open, no specific stimuli) and while being stimulated with a 500 Hz 125dbSPL tone burst and with a tendon hammer as they were for the cVEMP (acoustic stimuli) and oVEMP (tendon hammer stimuli). Balance was tested eyes open and closed.

Of all the conditions studied, only the tendon hammer hitting on the mastoid showed changes in sway area an medio-lateral displacement, with no effect on the rest parameters. We concluded that clinical acoustical and mechanical VEMP stimuli, has almost no effect on balance and gait in healthy subjects.

PP053

Clinical Testing for Vestibular Function

**HEARING LOSS IS ASSOCIATED WITH REDUCED OTOLITH AND CANAL FUNCTION IN US VETERANS****Jorge Manuel SERRADOR**<sup>1,2,3</sup>, Michael SCHUBERT<sup>4</sup>, Scott WOOD<sup>5</sup><sup>1</sup>*Department of Physiology, Pharmacology And Neuroscience, Rutgers, USA*<sup>2</sup>*Department of War Related Illness And Injury, Dept of Veteran Affairs, USA*<sup>3</sup>*Department of Cardiovascular Electronics, National University of Ireland Galway, Ireland*

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Hearing loss is one of the most common problems found in US military veterans, but vestibular pathology is less known. Recent evidence in healthy elderly over the age of 70 found that hearing loss was associated with reduced cVEMPs, indicative of impaired saccular function. We examined whether otolith (as measured by ocular torsion, cVEMP, and oVEMP) or canal function (as measured by vHIT) was impaired in a group of 47 veterans (10 females), age  $53.7 \pm 11.3$  years. We found that hearing loss indicated by increased pure tone threshold in the left ear was associated with reduced ocular torsion ( $-0.327$ ,  $P = 0.045$ ), while hearing in the right ear was not. In contrast, hearing loss in the right ear was associated with impaired right posterior canal function ( $-0.328$ ,  $P = 0.044$ ). No other canal vHIT measures were correlated with hearing loss. There was no correlation between hearing loss and cVEMP or oVEMP values on either side. These data demonstrate that hearing loss is associated with reduced ocular torsion, indicating impaired utricle function in the otoliths. In addition veterans with hearing loss demonstrated impaired right posterior canal function. Our data suggest hearing loss in veterans occurs with selective impairment of utricular and canal vestibular function, different from the vestibular impairment reported in healthy elderly civilians. It is possible that unilateral utricular dysfunction may be present, further work is needed. Supported by DoD grants W81XWH-14-2-0012 (Serrador) and W81XWH-14-1-0598 (Serrador).

PP054

Cochlear Implant and Vestibular Function

#### **BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV) AFTER COCHLEAR IMPLANTATION**

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**Objectives:** Cochlear implantations are very popularly performed for hearing rehabilitation. Complications have been reported rarely. Postoperative dizziness is one of common complications of cochlear implantation. We present this study to identify patients developing benign paroxysmal positional vertigo (BPPV) after cochlear implantation. **Materials and Method:** a retrospective study of 63 patients who submitted to cochlear implantation at the Keimyung University, Dongsan Medical Center from 2005 to 2014. this includes preoperative and post operative vertigo history, vestibular function test, imaging study.

**Result:** 4 patients had BPPV, on the cochlear implant side in 3 patients, and in the other ear in 1 patient. All cases was matters of lateral semicircular canal. 3 patients who suffered from BPPV on operation side had recurred symptom of BPPV.

**Conclusion:** BPPV is an uncommon development after CI. The observed incidence of BPPV becomes 6.6%. All of them felt subjectively relieved after the repositioning maneuver within 2 months.

PP055

Epidemiology

#### **UPDATE IN OTO SYPHILIS.**

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**Introduction:** Otologic manifestations in syphilis infections are variable in presentation; ranging from serous otitis media to sudden sensorineural hearing loss, hydrops and diverse vestibular manifestations. Central neurological manifestations have also been reported in late stages of the disease.



**Objective:** To determine the otologic manifestations of syphilis infection in latent stages.

**Method:** Prospective, longitudinal, observational study, comprising 129 patients with risk factors for syphilis, who presented to the neurotology consultation with cochlear and/or vestibular symptoms. Battery tests included VDRL and FTA-ABS in blood serum.

**Results:** 36 patients proved positive for syphilis (FTA-ABS blood serum). VDRL was negative in all patients. All 129 patients tested negative for HIV. Gender distribution was equitative. The age group most affected was comprised between 51–70 years (58.3%). 83.3% of the cases presented with hearing loss: in 70% of this patients the hearing loss was progressive while in the other 30% it presented as sudden hearing loss. 97.2% presented with vestibular symptoms: 55.6% vertigo, 36.1% gait disorders and 5.6% dizziness. All 36 patients were proposed for spinal tap and cerebrospinal fluid FTA-ABS: of which 4 (11.1%) tested positive, 30 (83.3%) tested negative and 2 patients (5.6%) refused the test.

**Conclusion:** Infectious diseases such as syphilis are still prevalent in developing countries, and clinical manifestations in the otologic area may vary; once diagnosed, neurological latent stages of the diseases must be ruled out.

PP057

Functional and Psychiatric Vestibular Disorders

### PSYCHIATRIC COMORBIDITY IN PATIENTS WITH DIZZINESS AND THE THERAPY OF PSYCHOTROPIC DRUGS

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**Objective:** We investigated 3 types of psychogenic dizziness (narrow type, wide type and psychiatric comorbidity) and the therapy of psychotropic drugs.

**Methods:** The 951 patients (304 men, 647 women, age range, 4–95; mean age  $60.3 \pm 18.1$  years) with dizziness were classified as otolaryngologic disorders: dizziness of unknown cause in 338 (35.5%), otogenic vertigo in 202 (21.2%), Meniere's disease in 150 (15.8%), chronic cerebral insufficiency in 149 (15.7%), BPPV in 75 (7.9%) and other types of diseases in 37 (3.4%).

**Results:** Narrow type was revealed in 165 (17.4%). Psychiatric comorbidity was revealed in 628 (65.4%). Of 628 patients, various types of psychiatric disorders were found, such as anxiety or panic disorders in 355 (56.5%), mood disorders in 116 (18.5%), adjustment disorders or post-traumatic stress disorders in 32 (5.1%), dissociative disorders in 8 (1.3%), other neurotic disorders in 21 (3.3%), organic mental disorders in 52 (8.3%) and schizophrenia in 28 (4.5%). These patients were not only treated by otolaryngologists, but also received psychiatric therapy, and 500 (80%) of these patients were prescribed psychotropic drugs. Minor tranquilizer was prescribed in 314 (62.8%), sleep medication in 174 (34.8%), antidepressant in 114 (22.8%), major tranquilizer in 81 (16.2%), anti-epileptic drugs in 34 (6.8%), anti-Parkinson's disease drugs in 19 (3.8%), other drugs in 39 (7.8%).

**Conclusions:** Our present study showed that there exists numerous number of psychogenic dizziness patients comorbid with various psychiatric disorders, indicating that further collaborations between psychiatrists and otolaryngologists might contribute to provide appropriate medication or therapy in these patients.

PP058

Gait, Posture, and Locomotion

### THE EFFECT OF OPTOKINETIC STIMULATION ON PERCEPTUAL AND POSTURAL SYMPTOMS IN VISUAL VESTIBULAR MISMATCH PATIENTS

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**Background:** Vestibular patients occasionally report aggravation or triggering of their symptoms by visual stimuli, which is called visual vestibular mismatch (VVM). These patients therefore experience discomfort, disorientation, dizziness and postural unsteadiness.

**Objective:** Firstly, we aimed to get a better insight in the underlying mechanism of VVM by examining perceptual and postural symptoms. Secondly, we wanted to investigate whether roll-motion is a necessary trait to evoke these symptoms or whether a complex but stationary visual pattern equally provokes them. Methods: Nine VVM patients and healthy matched control group were examined by exposing both groups to a stationary stimulus as well as an optokinetic stimulus rotating around the naso-occipital axis for a prolonged period of time. Subjective visual vertical (SVV) measurements, posturography and relevant questionnaires were assessed.

**Results:** No significant differences between both groups were found for SVV measurements. Patients always swayed more and reported more symptoms than healthy controls. Prolonged exposure to roll-motion caused in patients and controls an increase in postural sway and symptoms. However, only VVM patients reported significantly more symptoms after prolonged exposure to the optokinetic stimulus compared to scores after exposure to a stationary stimulus.

**Conclusions:** VVM patients differ from healthy controls in postural and subjective symptoms and motion is a crucial factor in provoking these symptoms. A possible explanation could be a central visual-vestibular integration deficit, which has implications for diagnostics and clinical rehabilitation purposes. Future research should focus on the underlying central mechanism of VVM and the effectiveness of optokinetic stimulation in resolving it.

PP059

Gait, Posture, and Locomotion

### FUNCTIONAL MEASURE OF GAZE SHIFTING DURING QUIET STANCE AND NATURAL WALKING IN NORMAL INDIVIDUALS

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Gaze shifting is commonly used in daily activities, such as walking on the street and avoiding oncoming traffic. We incorporated dynamic visual acuity test to develop a functional measure of gaze shift called gaze shift DVA (gsDVA) and compared the differences between the young (< 65 y/o) and old ( $\geq$  65 y/o) populations. Three monitors were placed 2 m in front of subjects (1 in the center, 2 in 60° on either side). An arrow flashed on the centered monitor, randomly directing the subject to gaze shift left or right. Once the subject's head rotated to a 60-degree range, an optotype would flash on the eccentric monitor for the subject to identify its orientation. The Optotype would disappear after an examiner entered the response. Gaze shift DVA, reaction time (RT) and head velocity were measured both in stance and walking at a self-selected speed. In 95 healthy adults (69 in young, 41.84  $\pm$  13.84 y/o, 26 in old, 73.28  $\pm$  5.63 y/o), we found gsDVA score was similar in both groups ( $p > 0,05$ ), but RT (left 1.369  $\pm$  0.39 s in young vs 2.408  $\pm$  1.90 s in old,  $p = 0.011829$ ; right 1.323  $\pm$  0.37 s in young vs 1.977  $\pm$  0.645 s in old,  $p = 0.000044$ ) and head velocity (left 189.47  $\pm$  82.10°/s in young vs 103.78  $\pm$  42.08°/s in old,  $p = 0.000$ ; right 206.84  $\pm$  82.27°/s in young vs 129.82  $\pm$  68.59°/ss in old,  $p = 0.000033$ ) reduced significantly in the old. We believe this measure will be a useful metric in evaluating dynamic visual acuity in different age groups.

PP060

Genetics, Development, and Regeneration

**VESTIBULAR FUNCTION IS ASSOCIATED WITH A RESIDUAL LOW-FREQUENCY HEARING LEVEL IN DFNB4 PATIENTS****Jinsei JUNG<sup>1</sup>**, Young Wook SEO<sup>1</sup>, Jae Young CHOI<sup>1</sup>, **Sung Huhn KIM<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Yonsei University College of Medicine, Korea*

DFNB4 is non-syndromic, autosomal recessive type of hearing loss with an enlarged vestibular aqueduct (EVA) caused by mutations in SLC26A4/pendrin. Although the characteristics of hearing loss are well known in DFNB4, vestibular function remains inconclusive. We evaluated the vestibular function of 31 patients with bi-allelic mutations in SLC26A4/pendrin and analyzed genetic, radiological, and audiological correlations with vestibular function. In a caloric test, unilateral and bilateral vestibulopathies were detected in 45.2% and 6.4% of patients, respectively; however, only 22.6% had subjective vertigo symptoms. While vestibular phenotype was not significantly associated with specific mutations in genetic alleles or the sizes of the endolymphatic sac and vestibular aqueduct, a residual hearing threshold at a low frequency (500 Hz) was definitely correlated with vestibular function in DFNB4 ( $p = 0.005$ ). These findings may indicate that vestibular function in DFNB4 deteriorates unilaterally in ears when hearing loss occurs unrecognized or due to head trauma. In conclusion, DFNB4 shows vestibular dysfunction, which is strongly linked to hearing loss at low frequencies without any allelic or anatomical predisposing factor.

PP061

Imaging of the Inner Ear and Vestibular System

**CT AND MRI IMAGING IN PATIENTS WITH P51S COCH MUTATION****Charlotte COLPAERT<sup>1,5</sup>**, Bruno TERMOTE<sup>2</sup>, Guy VAN CAMP<sup>3</sup>, Paul GOVAERTS<sup>4</sup>, Steven SCHEPERS<sup>2</sup>, Tony COX<sup>1</sup>, Kristof DEBEN<sup>1</sup>, Katrien KETELSLAGERS<sup>1</sup>, **Berina IHTIJAREVIC<sup>1,5</sup>**, Geert SOUVERIJNS<sup>2</sup>, **Sebastien JANSSENS<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology And Head & Neck Surgery, Jessa Hospital Hasselt, Belgium*<sup>2</sup>*Department of Radiology, Jessa Hospital Hasselt, Belgium*<sup>3</sup>*Department of Biomedical Sciences, Medical Genetics Centre, University of Antwerp, Belgium*<sup>4</sup>*Department of Otorhinolaryngology & Head And Neck Surgery, The Eargroup, Antwerp-deurne, Belgium*<sup>5</sup>*Department of Medicine And Health Sciences, University of Antwerp, Belgium*

**Introduction and aim:** Recently a new phenotypic and characteristic radiologic feature of DNA9 has been discovered in a series of 9 patients, all with the same P51S COCH gene mutation<sup>1</sup>. This study adds more patients to the series.

**Material and methods:** CT en MRI imaging of 15 patients who presented between 2007 and 2015 with otovestibular deterioration all caused by the same c.151C>T,p.Pro51Set (P51S) missense mutation in the COCH gene, were analyzed. The mean patients' age at the time of investigation was 60 years, and 27% were female.

**Results:** Eighty-seven percent of the patients had sclerotic lesions and/or narrowing in one or more semicircular canals on CT scan with a signal loss at corresponding areas on T2-weighted MR images. The posterior canals were affected in most cases (50%), compared with the superior (25%) and lateral canals (14%) or the vestibule (4%). Only 77% of the lesions on MR images were also visible on CT scans, suggesting a fibrotic process without calcification<sup>1</sup>. As the disease progresses, patients get more lesions visible on imaging and more severe hearing loss. Median PTA in unaffected ears is 49 dB HL versus 100 dB HL in affected ears.

**Conclusions:** An extended retrospective analyses of CT and MRI imaging in patients with the same P51S mutation in the COCH gene, confirmed the recently discovered characteristic radiologic feature.

PP062

Imaging of the Inner Ear and Vestibular System

**VISUALIZATION OF VESTIBULOCOCHLEAR NERVE TRACTS USING A DIFFUSION TENSOR MAGNETIC RESONANCE IMAGING METHOD****Zhengguang CHEN<sup>1</sup>**, Liqun ZHONG<sup>2</sup>, Xiaojia YUAN<sup>1</sup>, Menghuang XIA<sup>2</sup>, Shasha LI<sup>2</sup>, Tianzuo ZHAO<sup>1</sup>, Chunliang JI<sup>1</sup>, Zhongjian TAN<sup>1</sup>

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**Objectives:** The aim of this study was to visualize the vestibulocochlear nerve (CN8) and facial nerve (CN7) tracts, such as the segment of acoustic nerve (AN), cochlear nerve (CN) and vestibular nerve (VN) by using the diffusion tensor imaging (DTI) technique, and to evaluate the nerve's microstructure in the patient with clinically suspected Meniere's disease.

**Materials and Methods:** The records of four patients with suspected Meniere's disease and fifteen age-matched volunteers were enrolled using 3T MRI. The hearing levels of all patients and volunteers at the low, middle, and high frequencies were evaluated. The visualized CN8 and CN7 course and its position relative to the vessels were determined using the DTI and the contrast-enhanced magnetic resonance angiography (CE-MRA) with 3D Ziostation 2plus V2.1 software. The DTI metrics of the segment of AN, CN and VN were calculated for all participants, and their correlations with clinical findings were analyzed.

**Results:** The visualization of the fiber tractography in CN8, CN7, and the segment of AN, CN, VN was successful observed using DTI in 100% of the all participants. The fractional anisotropy (FA) and mean diffusivity (MD) delivered from DTI were determined in patients and volunteers. There were clearly significant differences (30.8, 15.4;  $p < 0.05$ ) in the CN and VN between the groups and had very good correlation with clinical results.

**Conclusions:** The present results suggest that DTI fused CE-MRA and MRI could be performed potentially with a view to facilitating improved visualization of the tract and associated pathology in cases of the Meniere's disease.

PP063

Imaging of the Inner Ear and Vestibular System

#### ENDOLYMPHATIC SPACE SIZE IN PATIENTS WITH VESTIBULAR MIGRAINE AND MENIERE'S DISEASE

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**Purpose:** Vestibular migraine (VM) and Meniere's disease (MD) are frequent causes of episodic vertigo. Comorbidity is common between VM and MD, and their symptoms overlap. It is occasionally difficult to distinguish between VM and vestibular MD. Because endolymphatic hydrops (EH) is a characteristic sign of MD, we attempted to evaluate endolymphatic space size in both diseases.

**Method:** Endolymphatic space size in the vestibule and the cochlea was evaluated in seven patients with VM and in seven age- and sex-matched patients with vestibular MD. For visualization of the endolymphatic space, 3 Tesla magnetic resonance imaging (3T MRI) was taken 4 hours after intravenous injection of gadolinium contrast agents using three-dimensional fluid attenuated inversion recovery (3D FLAIR) and hybrid of Reversed image Of Positive endolymph signal and native image of positive perilymph Signal (HYDROPS) techniques. The degree of EH in the vestibule and cochlea were classified into three grades; no, mild and significant.

**Result:** In the vestibule of VM patients, EH was not observed, with the exception of two patients with unilateral or bilateral EH. In contrast, in the vestibule of patients with vestibular MD, all patients had significant EH, bilaterally or unilaterally.

**Conclusion:** These results indicate that endolymphatic space size is significantly different between patients with VM and vestibular MD.

PP064

Imaging of the Inner Ear and Vestibular System

**EARLY EXPERIENCE WITH A NEW TECHNIQUE TO IMAGE THE VESTIBULAR CORTEX ON FUNCTIONAL MRI (fMRI)****Jeremy HORNIBROOK**<sup>1,2</sup>, Edward FLOOK<sup>1</sup>, Tracy MELZER<sup>3</sup>, Melissa BABBAGE<sup>2</sup>, Gurjuot VRAICH<sup>1</sup>, Philip BIRD<sup>1,2</sup><sup>1</sup>*Department of Otolaryngology, Christchurch Hospital, Christchurch, New Zealand*<sup>2</sup>*Department of Otolaryngology, the Communication Disorders the University of Canterbury, Christchurch, New Zealand*<sup>3</sup>*Department of Otolaryngology, the New Zealand Brain Research Institute, Christchurch, New Zealand*

Very different areas of the cerebral cortex have been labelled as vestibular. More recently fMRI and PET scans have confirmed it is the parietoinuslar cortex. Delivery of the vestibular stimulus (optokinetic, caloric for canals and tone bursts for otoliths) in the scanner has been challenging. It has been claimed that handedness correlates with increased vestibular cortex activity on the ipsilateral side.

It was decided to investigate whether a head tap stimulus might be the simplest way of imaging the vestibular cortex on fMRI. One criticism is that it may activate other senses such as hearing and touch.

A tapping and pressing device was attached to the horizontal bar of the head coil of a 3 Tesla General Electric MRI scanner. After showing vestibular cortex response in a first volunteer nine subjects have been tested. All had prior testing of hearing (normal for age), oVEMPs from a head tap, with the exception of one with a removed acoustic neuroma and one profoundly deaf subject with unrecordable tap oVEMPs.

In the scanner the first group was tested with sequences of taps and gentle pressing which separated vestibular and touch responses, with unilateral absence of vestibular activity in the acoustic neuroma subject and no response in the subject with no tap oVEMPs. In three left-handed subjects and three right-handed subjects there was no significant increase in vestibular cortex activity corresponding with handedness.

Early experience has demonstrated that a simple head tap stimulus in the fMRI scanner can achieve a simultaneous vestibular cortex response.

PP065

Imaging of the Inner Ear and Vestibular System

**DOES MRI ENDOLIMPHATIC HIDROPS VISUALIZATION CORRELATE WITH AUDIO-VESTIBULAR FINDINGS?****Raquel MANRIQUE**<sup>1</sup>, Maria Cecilia SALOM<sup>3</sup>, Pablo DOMINGUEZ ECHÁVARRI<sup>2</sup>, Jose Luis ZUBIETA<sup>2</sup>, Fanny Meylin CABALLEROS<sup>2</sup>, Nicolas PEREZ<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, University of Navarra Clinic, Spain*<sup>2</sup>*Department of Radiology, University of Navarra Clinic, Spain*<sup>3</sup>*Department of Otorhinolaryngology, Hospital Universitario Central De Asturias, Spain*

**Objectives:** To study the feasibility of vestibular endolymphatic hydrops visualization by T2-FLAIR MRI after intravenous gadolinium, and its correlation with audio-vestibular functional tests.

**Material and methods:** 34 patients were clinically categorized into two groups: 1) sensorineural fluctuating hearing loss (SNFHL) and 2) definite Ménière's disease (MD). Clinical evaluation included: duration of disease, number of spells (hearing loss or vertigo) in the last 6 months and pure tone audiometry (PTA), video head impulse test and vestibular evoked myogenic potential (VEMP). With a 3T MRI unit, T2-FLAIR imaging was performed 4 hours after intravenous gadolinium administration. The images were fused with a heavily T2-weighted sequence and then evaluated by one single reader, blinded to the final diagnosis. The laterality and grade (mild, moderate or severe) of vestibular endolymphatic hydrops was recorded and its relationship with audio-vestibular functional tests was studied.

**Results:** In 13 patients with SNFHL, T2-FLAIR was normal in 5, and showed hydrops in 8. Besides, vestibular testing results are pathological in the latter, suggesting that those patients had actually a MD. In 21 patients with MD, T2-FLAIR showed unilateral or bilateral vestibular hidrops concordant with clinical tests in all cases. Grade of hydrops positively correlated with level of hypoacusia and clinical severity of MD.

**Conclusions:** This technique allows vestibular endolymphatic hydrops visualization that correlates with clinical information. The radiological evaluation of patients with SNFHL and MD provides an insight to a better phenotypic characterization of those patients when combined with a complete functional evaluation.

PP067

Meniere's Disease and Related Disorders

**VEMPS PRESERVED AFTER TRIPLE SEMICIRCULAR CANALS OCCLUSION IN A CASE OF INCAPACITATING MENIERE'S DISEASE**

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**Objective:** We report the audiologic and otolithic vestibular functions preserved in a patient with incapacitating definite Ménière's disease.

**Case report:** The Patient was a 30-year-old female. The triple semicircular canals occlusion surgery was performed after rounds of routine conservative medication and unsuccessful endolymphatic sac decompression. The vestibular and auditory function were analysed pre- and post-operatively.

**Results:** Vertigo has been controlled very well during 18 months of follow-up. No acute hearing deterioration occurred after surgery and the otolithic vestibular function were preserved very well as seen both oVEMP and cVEMP could be elicited both before and after operation.

**Conclusion:** The audiologic and otolithic vestibular function might be preserved after triple semicircular canal occlusion surgery in the management of Ménière's disease.

PP068

Meniere's Disease and Related Disorders

**FREQUENCY CHARACTERISTICS OF THE SEMICIRCULAR CANALS DAMAGE IN MENIERE'S DISEASE**

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**Objective:** Assessment semicircular canal damage and its frequency characteristics on the Meniere's disease patients.

**Method:** All the 67 Meniere's disease patients have finished the Video-Head Impulse Test (vHIT) to detect semicircular canal function of high frequency range, Head shaking test(HST) to detect semicircular canal function of middle frequency range, and caloric test(CT) to detect semicircular canal function of low frequency range. The video head impulse test gain (vHIT-G), head shaking nystagmus (HSN), parameters of the unilateral weakness (UW) and their characteristics are analysed.

**Results:** The positive rate of the three tests vHIT, HSN and CT were 23.9%, 41.8% and 70.1%, respectively. A statistically significant difference ( $P < 0.05$ ) was found among the three tests. In different UW value interval, the positive rates of HST and vHIT are gradually increased as UW value increases.

**Conclusions:** The semicircular canal damage occurs mainly in the low frequency range for patients with Meniere's disease, also affects the middle and high frequency region. There are few injury to stride frequency range. The HST and vHIT from middle to high frequency can not be used for the screening test to evaluate the semicircular canal function in Meniere's disease.

PP069

Meniere's Disease and Related Disorders

**EPIDEMIOLOGICAL CHARACTERISTICS OF DELAYED ENDOLYMPHATIC HYDROPS IN JAPAN-UPDATE**

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From 1998 to 2014, nationwide, multi-center surveys on delayed endolymphatic hydrops (DEH) were performed by the Research Committee of Meniere's disease and the Research Committee of the Peripheral Vestibular Disorders. DEH cases were sampled by the members of the Committees. The diagnostic criteria of DEH proposed by the committee of Japan Society for Equilibrium Research were used. The epidemiologic characteristics of the ipsilateral and contralateral types of DEH including sex ratio, clinical symptoms, diagnosis of precedent deafness, onset age at precedent deafness, time delay of onset between precedent deafness and DEH etc. were analyzed. The rate of ipsilateral type of DEH was almost equal to that of contralateral type. In DEH, the number of female patients was slightly predominant to that of male patients. The most common diagnosis of precedent deafness was sudden deafness, Mumps deafness and deafness of unknown cause onset in early childhood.

PP070

Meniere's Disease and Related Disorders

### **COMPLIANCE AND THE EFFECT OF HEARING AID ON SYMPTOMS OF MENIERE'S DISEASE: A PILOT STUDY**

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**Background:** Not only vertiginous symptom but also cochlear symptoms of Meniere's disease (MD) can affect the everyday life of the patients with Meniere's disease.

**Purpose:** This pilot study was performed to explore the compliance and brief effect of hearing aid (HA) on cochlear symptoms of MD.

**Methods:** Twenty five patients fitting American Academy of Otolaryngology-Head and Neck Surgery criteria for Meniere's disease who had non-fluctuating hearing loss and were prescribed hearing aid on the affected ear at our otology clinic between 2009 and 2015 were included in this study. The medical records were retrospectively reviewed to investigate the compliance of continuous usage, degree of functional gain, improvement of speech perception, and the impact of HA on tinnitus.

**Results:** More than 90% of the patients were prescribed CIC type hearing aids while others were prescribed Bi-CROS or RIC type hearing aids depending on the hearing level. During the mean follow-up period of 24.2 months, all subjects continued to use their hearing aids with a regular programming of 3~6 month interval, which indicates the successful compliance of unilateral hearing aid in patients of MD. Improvement of hearing was observed in sound field verification. Even the patients with non-serviceable hearing continuously used HA taking the advantages of sound detection, localization, and decrease in tinnitus.

**Conclusion:** Hearing aid seems to be a good therapeutic tool for relieving the cochlear symptoms of Meniere's disease. Further case-control study is needed to show the effect of hearing aid on individual cochlear and vestibular symptoms of MD.

PP071

Meniere's Disease and Related Disorders

### **CHARACTERISTICS OF TINNITUS IN PATIENTS WITH MENIERE'S DISEASE**

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**Objectives:** To characterize tinnitus associated with four stages of Meniere's disease and to investigate the correlation between tinnitus and the vestibular indices.

**Methods:** We retrospectively reviewed the medical records of the patients with definite Meniere's disease who visited our dizzy clinic between Oct 2010 and Jan 2016. Patients received audiological and vestibular function

tests after thorough history taking and physical examination. The stage has been determined based on the four-tone average of the pure-tone thresholds at 0.5, 1, 2, and 3 kHz before treatment according to the AAO-HNS Committee on Hearing and Equilibrium guidelines. The patients were asked to rank their subjective tinnitus, dizziness, and psychological status using VAS for loudness/ awareness/ annoyance/ effect on life, Tinnitus Handicap Inventory (THI), Dizziness Handicap Inventory (DHI), the Beck Depression Inventory (BDI), and Korean version of Brief Encounter Psychosocial Instrument (BEPSI-K).

**Results:** Twenty men aged  $52.5 \pm 3.4$  years and 40 women aged mean  $58.4 \pm 2.2$  years were involved. Stage 1/2/3/4 included 18/14/23/5 patients. Matched loudness and pitch, SP/AP ratio, VAS scores, THI, DHI, BDI and BEPSI-K did not differ across the four groups. THI showed weak correlation with DHI ( $r = 0.463, p = 0.046$ ), BDI ( $r = 0.568, p = 0.001$ ), and BEPSI-K ( $r = 0.499, p = 0.004$ ).

**Conclusion:** Our study revealed that various tinnitus indices including self-report severity scores are not significantly associated with the stages of Meniere's disease, i.e. the degree of hearing loss. We also suggest that the tinnitus and dizziness distresses have weak correlation.

PP072

Meniere's Disease and Related Disorders

**ADRENERGIC STIMULATION – INDUCED ELECTROGENIC TRANSPORT MEDIATED BY K<sup>+</sup> AND CL<sup>-</sup> CHANNELS IN HUMAN ENDOLYMPHATIC SAC**

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The endolymphatic sac (ES) is a cystic organ that is a part of the inner ear and is connected to the cochlea and vestibule. The ES is thought to be involved in inner ear ion homeostasis and fluid volume regulation for the maintenance of hearing and balance function. Authors reported the first functional experiments on electrogenic transport-mediated by K<sup>+</sup> channels in human ES. In this study, we tried to investigate if adrenergic stimulation influences the electrogenic transport in human ES using electrophysiologic and pharmacologic methods because stress-hormone level is thought to be related to aggravation of vertigo and hearing loss in Meniere's disease. As a result, we identified that alpha (epinephrine 100 uM) and beta adrenergic receptor stimulator (isoproterenol 10 uM, CGP-20712A 100 uM, and ICI-118551 100 uM) increased K<sup>+</sup> and Cl<sup>-</sup> channel-mediated electrogenic transport in human ES. On the contrary, those adrenergic stimulator-induced electrogenic transports were absent in the ES of Meniere's disease patients. It is tempting to speculate that electrogenic transport by adrenergic stimulation contributes to the regulation of inner ear homeostasis and fluid volume regulation by providing appropriate endolymphatic sac potential and fluid shift accompanied by Cl<sup>-</sup> transport and the absence of those electrogenic transport causes aggravation of endolymphatic hydrops in Meniere's disease patients.

PP073

Meniere's Disease and Related Disorders

**MÉNIÈRE'S DISEASE WITH LARGE VESTIBULAR AQUEDUCT SYNDROME**

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**Objective:** The classical hypothesis that Ménière's disease results from a narrowed vestibular aqueduct and an enlarged endolymphatic sac has been increasingly challenged by recent literature. Today, with advanced technologies, high-resolution CT and contrast-enhanced MRI has allowed clinicians to further investigate the relationship between vestibular aqueduct's dimensions and the presence of an enlarged endolymphatic sac in Ménière's. This advancement in technology has led to an increase in recent literature illustrating that enlarged vestibular aqueduct (EVA) and endolymphatic hydrops (EH) do seem to exist in Ménière's. Adding to the increasing literature, a patient that has been on follow-up at our center for 10 years, who has clinical and vestibular investigations suggestive of Ménière's, demonstrates EVA radiologically.



**Method:** A case report and current literature review on the increasing evidence that EH may not be exclusively present in Ménière's disease.

**Results:** Extensive vestibular and audiological investigations that were carried out suggested a clinical diagnosis of Ménière's disease. However, radiological study that was used to further support the diagnosis of Ménière's, demonstrated EVA instead of EH. This suggests that in Ménière's, EVA and EH may be due to a common primary dysfunction of inner-ear fluid homeostasis and may exist individually or together.

**Conclusion:** The pathophysiology of Ménière's disease has been constantly challenged by the today's literature. Together with recent evidence from various case series and reports, our study postulates that EVA and EH may co-exist with Ménière's and that the speculated theory that a small vestibular aqueduct predisposes one to Ménière's disease may need revision.

PP074

Ocular Motility: Physiology and Pathology

### **INFLUENCE OF ALCOHOL ON GAZE HOLDING MECHANISM**

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Gaze-evoked nystagmus (GEN) is an ocular motor finding commonly observed in cerebellar disease, characterized by abnormal centripetal eye drift with centrifugal correcting saccades at eccentric gaze. Acute alcohol intoxication, by temporarily inhibiting cerebellar function, also induces GEN. GEN has been extensively investigated in cerebellar patients, yet a detailed analysis of the influence of alcohol on gaze-dependent eye drift is missing. We examined gaze-holding in healthy human subjects before (baseline) and 30 minutes after intake of the estimated alcohol amount needed to reach a blood alcohol content (BAC) of 0.06% ( $n = 15$ ) and 0.10% ( $n = 10$ ), respectively. Changes in gaze holding were quantified by analyzing eye drift velocity as a continuous function of gaze position over a large range ( $\pm 40$  deg) of horizontal gaze angles. The position-velocity relationship was described using a two-parameter tangent model.

Compared to baseline, eye drift velocity increased for all gaze eccentricities by a factor 2 at 0.06%BAC and by a factor  $> 2.5$  at 0.10%BAC. Five subjects tested at 0.10%BAC showed a further nonlinear increase of eye drift velocity at large gaze angles. Similar linear and nonlinear transformations were also described in patients affected by cerebellar degenerations. We suggest that alcohol-induced GEN could provide a model of GEN in cerebellar pathology. A subgroup of cerebellar patients, however, demonstrated nonlinear increases of drift velocity in absence of an overall scaling, a condition not reproduced by our experiment. We hypothesize that alcohol cannot reproduce this pattern because of its homogeneous effects on all structures for gaze holding in the cerebellum.

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PP075

Ocular Motility: Physiology and Pathology

### **VISUAL MODULATION OF PENDULAR NYSTAGMUS IN MULTIPLE SCLEROSIS: IMPLICATION FOR MECHANISM**

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**Background and Objective:** Acquired pendular nystagmus (APN) may occur in multiple sclerosis (MS). The proposed mechanisms include delayed conduction of visual information for ocular stabilization and unstable neural integrator for feedback control. We determined the effects of visual inputs on the nystagmus intensity and the effects of saccades on the phase of nystagmus in a patient with monocular pendular nystagmus due to MS.

**Methods:** We determined the effects of vision on nystagmus intensity by measuring nystagmus in various conditions; while fixating on a target in the light and in darkness, in complete darkness without a target, and while monocular viewing. We also applied density filters to either eye to change the asymmetry of visual inputs between the eyes. We investigated somatosensory modulation of the nystagmus by applying a soft contact lens onto the eye with pendular nystagmus. We also measured any phase shift of the pendular nystagmus by horizontal saccades.

**Results:** The nystagmus was observed only in the eye with more severe visual loss. The nystagmus disappeared in darkness. Monocular viewing with either eye markedly suppressed the nystagmus. The nystagmus increased when the asymmetry in visual inputs was increased between the eyes using density filters. Horizontal saccades resulted in a significant phase shift of the nystagmus.

**Conclusion:** The difference in visual inputs between the eyes appears to give rise to ocular oscillatory signals probably in the neural integrator and untimely feedback due to delayed conduction results in more severe or monocular nystagmus in the eye with severe visual loss.

PP076

Ocular Motility: Physiology and Pathology

### **WHY DONDEERS AND LISTING'S LAW MATTER BUT CANNOT ACCOUNT FOR BINOCULAR SINGLE VISION**

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Donders' and Listing's law restrict the rotational freedom of the eyes such that ocular torsion remains invariant during visually-guided eye movements. As a consequence, the torsional orientation of the images cast on the right and left retina during explorations of the visual surround remains invariant. Although these restrictions in principle help solving the problem of binocular correspondences in stereopsis they render binocular coordination of the rotation planes in near vision impossible except for targets in the horizontal plane of regard (Hess & Misslisch, JNP 2015). Here we studied the binocular coordination during far-to-near re-fixation saccades by asking how well fixations of far and near targets are binocularly coordinated. Three-dimensional eye movements were recorded in three behaviorally trained rhesus monkeys during a far-to-near re-fixation task. Eye movements were analyzed in terms of compounded rotations including the default Donders-Listing kinematics of far vision. We found that ocular torsion complemented the Donders-Listing kinematics by enabling the eyes to fuse the lines of sight on the estimated target location in near visual space. In trials where the animals avoided looking directly at the target light, the re-fixation saccades landed with high accuracy on neighboring positions that linearly extended to the estimated target position in the binocular visual field. We conclude that oculomotor fusion is achieved by active cyclotorsion of the eyes for fixation of objects in the near visual field off the horizontal plane of regard. The underlying mechanisms appear to operate independently of the Donders-Listing kinematics in far vision.

PP077

Motion Sickness and Other Vestibular Disorders

### **MOTION SICKNESS AND SOPITE SYNDROME ASSOCIATED WITH PARABOLIC FLIGHTS: A CASE REPORT**

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**Objective:** The purpose of this paper was to provide an extensive description of a case of sopite syndrome, a manifestation of motion sickness scarcely described in the literature.

**Design:** The following questionnaires were used to assess sopite syndrome symptoms pre, during and post parabolic flight; Misery Scale rate, Positive and Negative Affect Scale, the Motion Sickness Assessment Questionnaire and the Epworth Sleepiness Scale.

**Study sample:** Case report of a 35-year old female compared to a control group ( $n = 26$ ).

**Results:** We describe of sopite syndrome during parabolic flight. The subject reported drowsiness and she noted mood changes such as irritation and annoyance. Furthermore, she was not able to perform her assigned task. Her symptoms escalated into extreme fatigue and the inability to stay awake. Nauseogenic symptoms improved, but soporific symptoms persisted for several hours after the motion stimulus (i.e. parabolic flight).

**Conclusions:** This case points towards the need for controlled studies to assess the prevalence of this syndrome among the general population and select groups. Future research should focus on developing tests for personnel screening and explore treatment options.

PP078

Ocular Motility: Physiology and Pathology

### **VESTIBULAR AND OCULAR MOTOR FUNCTION PRIOR TO AND AFTER THERAPEUTIC APHERESIS IN MULTIPLE SCLEROSIS**

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**Background:** Many patients with multiple sclerosis (MS) have vestibular disorders. Some MS patients are resistant to steroid therapy. In them an alternative therapy could be therapeutic apheresis (TA).

**Purpose:** This study aimed to demonstrate that testing the vestibular and the ocular motor function is an objective approach in proving the positive effect of TA with small nano-membrane plasmafilter in treatment of steroid resistant MS.

**Method:** Five patients with relapsing-remitting cerebral MS with dizziness and imbalance, resistant to steroid therapy and not tolerating disease modifying therapy were tested with sinusoidal acceleration, pursuit tracking and optokinetic test prior and 20 days after treatment with TA using small nano-membrane plasmafilter. First four sessions were conducted every other day, in order to filter maximal volume of the plasma, 5-th – after 30 days, 6-th – 3 months later, and 7-th – 6 months later. During each session 1500–1000 ml plasma was substituted with saline solution only.

**Results:** Symptoms were reduced. The vestibulo-ocular reflex during sinusoidal harmonic acceleration showed consistent improvement of the function with respect to both – directional preponderance and gain. The improvement in the smooth pursuit and the fast eye movement was to a lesser degree. The most expressed improvement was registered for the optokinetic system with respect to the gain of the horizontal optokinetic nystagmus.

**Conclusion:** Objective methods of measuring vestibular and ocular-motor functions are useful in assessing MS treatment when these systems are affected. TA with nano-membrane small plasmafilter even alone might be effective therapeutic option for steroid resistant MS.

PP079

Motion Sickness and Other Vestibular Disorders

### **THE EFFECT OF CONTINUOUS POSITIVE AIRWAY PRESSURE THERAPY ON DIZZINESS PATIENTS**

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**Objective:** To implore the effect of CPAP (Continuous Positive Airway Pressure) therapy on dizziness patients and its mechanism.

**Method:** 75 dizziness patients were enrolled from September 2011 to November 2014. All patients accepted polysomnographic test, Dizziness Handicap Inventory, Pittsburgh Sleep Quality Index and Epworth Sleepiness Scale

before and after CPAP therapy. Patients were divided into three groups according to Dizziness Handicap Inventory score: mild dizziness group ( $0 < \text{DHI} \leq 30$ ), moderate dizziness group ( $30 < \text{DHI} \leq 60$ ), severe dizziness group ( $60 < \text{DHI} \leq 100$ ); divided into three groups according to therapy time: (0–3] months group, (3–6] months group, (6–12] months group; divided into four groups according to age: young group (age  $< 45$ ), middle age group ( $45 \leq \text{age} < 60$ ), younger old group ( $60 \leq \text{age} < 75$ ) and old group (age  $\geq 75$ ).

**Result:** 1. There was a significant difference in all dizziness patients before and after CPAP therapy according DHI. 2. Different levels of dizziness had no impact on improving DHI during CPAP therapy ( $P = 0.198$ ). However, the effectiveness of modifying OSAHS group sleep disorder decreased when patients had heavier dizziness. 3. Treating by CPAP after three months could significant improve patients dizziness ( $P = 0.002$ ). 4. The dizziness of the patients in younger old group and old group have significant difference after CPAP therapy ( $P = 0.002$ ,  $P = 0.001$ ), but only younger old group has better sleep.

**Conclusions:** Dizziness level of patients with sleep disorder were significantly improved after CPAP therapy only.

PP080

Motion Sickness and Other Vestibular Disorders

### IMPACT OF SHORT INPATIENTS STAY MANAGEMENT ON ACUTE ISOLATED VERTIGO IN EMERGENCY DEPARTMENT

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**Aim:** To evaluate how a strategy of short inpatients stays (SIS) on patients with a complaint of acute isolated vertigo (AIV) in an Emergency Department (ED) can reduce inappropriate admissions.

**Method:** A before/after study was made from 2009 to 2014. Patients presenting in a Northwestern Italian ED suffering AIV were included. Before 2011 patients with AIV without other neurological deficits (AIV) not resolving in about six hours after symptomatic therapy were admitted in a specialistic ward. From 2012 patients with AIV not responding to symptomatics started to be observed as inpatients for 36 hours in the ED in order to better define diagnoses and therapeutic strategies as outpatients. Rate of admission and disposition were analyzed in two groups before (2009–2011) and after (2012–2014) implementation of SIS.

**Results:** During the whole period of the study AIV accounted for about 1% of all visits (4761/469477). The SIS strategy on patients with AIV allowed to reduce overall admissions from 13.7% in the first group to 9.9% in the second one. While admissions in Neurology unit substantially remained unmodified in the two groups (2.8% vs 2.7%), those in ENT unit were significantly lowered by implementation of the new strategy (9.0% vs 4.4%).

**Conclusion:** SIS stay seems to be a reliable and effective mean to reduce inappropriate admissions for ED patients with AIV.

PP081

Motion Sickness and Other Vestibular Disorders

### A STUDENT BOY GAMER COMPLAINING NAUSEA, HEADACHE AND DIZZY FEELING – A CASE REPORT-

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**Background:** Computer games have widely spread, all over the world, nowadays. There can be problems, which are addiction, sickness and accommodation problem of the eyes.

**Objectives:** To prove the patient's accommodation problem of the eyes and whether or not we can record his unusual eye movements.

**Case report:** A 13-year-old boy came to see our outpatient clinic of pediatrics department complaining nausea, headache and dizzy feeling, in particular, after classes, during he studies and/or his daily living. His parents were worried about it.

Surprisingly, he experienced no problems during he played the games, which are his favourite the PlayStation 4 (PS4). He loves playing shoot-'em-up games and stays up all night or for hours on end everyday. He plays the PS4 about six hours in average. No neurological findings were found but he complained nausea, headache and dizzy feeling. Finally, he was referred to our ENT department.

Neuro-otological findings were as follows: Vergence and divergence nystagmus were found in EOG. Unusual eye movements were found and analysed by Image J software for bilateral recording VOG (ON-1). Treatment was in hospital for four days. And we only allowed not to play the games and not to study at all. We advised him to take an anti-migraine agent whenever he wants.

**Discussion:** There is kind of embarrassing situation but most students stay up all night playing games. We must discuss, when the time comes, whether their games are bad for our health, in particular, worse for children and students.

PP082

Animal Models and Molecular Approach

### **EFFECT OF LOW LEVEL LASER THERAPY (LLLT) ON VESTIBULAR SYSTEM AFTER GENTAMICIN OTOTOXICITY**

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**Aim:** To develop bilateral vestibulopathy animal by gentamicin administration using rats and to see effect of transmeatal LLLT. **Method:** Rats into control(C), laser(L), and histology groups(H). Animals received gentamicin(GM) intravenously once daily for 3 days. The animals underwent sinusoidal oscillation before GM, 1, 3, 7 days post injections. LLLT irradiated into left ear canal for 7 days, starting 1 day post the GM injection. The H group animals were irradiated through left ear of L group for 3 days, starting 1 day post 3 days GM. C and L groups were sacrificed on 9th day and H group was sacrificed on the 7th day.

**Results:** The gain of the C group was significantly decreased bilaterally in 3 and 7 days. The gain of the right ear of L group was decreased significantly in 3 and 7 days. In left ear, gain was decreased in 3 days post LLLT but this gain was improved significantly on 7th day, being much closer to the pre-GM level. The number of cupular hair cells in H group on the 3rd day, was significantly lower in non-laser treated right ears comparing to laser-treated left ears and control group rats.

**Conclusion:** Transmeatal LLLT restores damaged vestibular function and vestibular hair cells in rats on post gentamicin induced ototoxic damage.

PP083

Animal Models and Molecular Approach

### **NOISY GALVANIC VESTIBULAR STIMULATION MODULATES THE EXCITABILITY OF THE STRIATUM IN RATS**

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**Background/Objectives:** Several clinical trials have shown that noisy galvanic vestibular stimulation (noisy GVS) can relieve symptoms of Parkinson's disease (PD). However, mechanisms how noisy GVS alleviates symptoms of PD are not clear. Vestibular system takes part in functions of the basal ganglia. Especially, vestibular information enters the basal ganglia mainly through the striatum. A lot of neuronal pathways between the vestibular system and the striatum have been proposed. Furthermore, symptoms of PD are mainly caused by the abnormal neuronal activity in the striatum. Therefore, this study was designed to observe alterations of evoked field potential after noisy GVS.

**Methods:** All adult male Sprague-Dawley rats were paralyzed with gallamine triethiodide and artificially ventilated. After that, we stimulated contralateral motor cortex to evoke field potentials and recorded evoked potential from ipsilateral striatum before and after the galvanic stochastic stimulation of the horizontal semicircular canal nerve bilaterally under anesthesia. The baseline evoked potentials were measured during 10 minutes before noisy GVS. Noisy GVS continued for 30 minutes and then a recording was resumed for 1 hour.

**Results:** Recording evoked field potentials in the striatum revealed that amplitudes of evoked potential gradually increased or decreased during and after noisy GVS. Moreover, slow oscillations showed decreasing tendency after noisy GVS. **Conclusion:** These electrophysiological evidences propose that the noisy electrical stimulation to the peripheral vestibular apparatus may induce the plasticity of the corticostriatal pathway and modulate neuronal activation in the striatum.

PP084

Vestibular Migraine

### CLINICAL CHARACTERISTICS OF PEDIATRIC MIGRAINE RELATED DIZZINESS AND THE EFFICACY OF ELECTROCOCHLEOGRAPHY

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Dizziness is less frequent but are not rare in pediatric population, and the prevalence of vestibular disorders ranges between 5% and 18%. The predominant forms of vertigo in children are benign paroxysmal vertigo of childhood (BPVC), and vestibular migraine (VM), which are related with headache. The purpose of this study is to analyze the clinical characteristics and vestibular function test in dizzy children with or without headache, which would provide a proper diagnostic approach.

A total of 102 children with dizziness who underwent vestibular function test were included in this study. These patients were retrospectively reviewed based on clinical charts. The average age of the patients was 10.79 years (range: 3–15). All patients performed questionnaires and were observed under frenzel nystagmography nystagmus. Electrocochleography, caloric and VEMP tests were performed in 74, 38 and 45 patients respectively.

Fifty two patients (51%) reported both dizziness and headache. Most common diagnosis was BPVC and vestibular migraine, but there were patients with Meniere's disease, orthostatic intolerance, and labyrinthine concussion who had headache simultaneously. Unilateral caloric weakness was reported in 28.9% patients, and VEMP asymmetry in 20% patients, but there was no difference between headache group and non-headache group. However, the SP/AP ratio was increased in pediatric headache related dizziness group and it was statistically significant ( $p = 0.029$ ).

Most common diagnosis of dizzy children is BPVC and vestibular migraine. Abnormality of vestibular function was relatively common in pediatric dizziness, and also endolymphatic hydrops was increased in pediatric dizzy patients with headache.

PP085

Motion Sickness and Other Vestibular Disorders

### UNILATERAL CENTRIFUGATION INDUCES DEREALIZATION SYMPTOMS IN HEALTHY ADULTS

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**Aim:** To assess depersonalization/ derealization (DD) symptoms during utricular stimulation by unilateral centrifugation in healthy adults.

**Methods:** 91 subjects (19 to 83 y.o., 46 women) participated in the study. They denied having a history of dizziness, vertigo, unsteadiness, hearing loss, neurological or psychiatric disorders. After a health screen, subjects responded to a standardized questionnaire of balance symptoms, the Hamilton Depression Rating Scale, the Zung Instrument for Anxiety Disorders and the DD inventory by Cox and Swinson. Then, vestibular evaluation was performed, including unilateral centrifugation (300°/s peak velocity, 3.5 cm), when subjects reported their DD symptoms for a second time.

**Results:** All subjects had vestibular responses within normal limits. None of them had anxiety but 20 of them had symptoms of depression. Centrifugation induced an increase of 24/28 DD symptoms and of the total DD score (“t” test,  $p < 0.01$ ); the most frequent symptoms, which also showed a frequency increase  $> 30\%$ , were: Surroundings seem unreal, Body feels strange, Events seem to happen in slow motion and Feel “spacy” or “spaced out”. The first DD score (before centrifugation) was related to age, but the second DD score was not related to age, gender, depression, use of tobacco or alcohol or the report of balance symptoms (ANCOVA,  $p < 0.05$ ).

**Conclusion:** In healthy adults with no history or evidence of vestibular disease, unilateral centrifugation may provoke DD symptoms, mainly related to the feeling of unreality, independently from age, gender or the report of symptoms of anxiety or depression.

PP086

Genetics, Development, and Regeneration

### **GUIDED GROWTH OF THE AUDITORY NEURONS – BIOACTIVE PARTICLES TOWARDS A GAPLESS NERVE-COCHLEAR IMPLANT INTERFACE**

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Cochlear implants (CI) have been used to restore hearing in patients for more than three decades. Despite continuous development, frequency discrimination could not be significantly improved. A reason for this is the anatomical gap between the neurons and the electrode, which causes current spread and unspecific neural stimulation. One possible strategy to close this anatomical gap is to guide the growth of peripheral dendrites closer to CI electrodes through targeted slow release of neurotrophins.

Biodegradable calcium phosphate sphere nanoparticles (CPS-NP) were produced and coated on CI electrodes using a thin layer for cellulose. The capacity of uptake and release of neurotrophins from the nanoparticles were investigated by tracing of <sup>125</sup>I labeled glia cell line-derived neurotrophic factor (GDNF). The axon guidance effect of slow released neurotrophins was studied in an *in vitro* model.

CPS-NP coating bound and released GDNF with an association rate constant of  $6.3 \cdot 10^3 \text{ M}^{-1}\text{s}^{-1}$  and dissociation rate of  $2.6 \cdot 10^{-5} \text{ s}^{-1}$  respectively. Resprouted neurites from human and mouse vestibulocochlear ganglion explants found and established direct contact with GDNF-loaded CPS-NP coatings on electrodes placed 0.7 mm away in a 3D culture system.

Preliminary results suggest that neurotrophin delivery through CPS-NP coating on CI electrodes is a plausible way to close the anatomical gap between the auditory neurons and CI electrodes. By overcoming this anatomical gap, advanced technologies including micro-sized electrodes could be introduced to CI, which opens up the possibilities to increase the total number of stimulations points and selective neural activation, and improve the fine hearing of CI users.

PP087

Central Vestibular Disorders

### **CORRELATIONS BETWEEN NEUROTOLOGICAL FINDINGS AND MR IMAGING IN SUPERFICIAL HEMOSIDEROSIS (SS)**

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To describe the neurotological findings and MR imaging in patients with cochleo-vestibular deficit due to SS of CNS.

Three case reports: Nr.1: 69-year-old man with progressive bilateral hearing loss, tinnitus and progressive ataxia since 10 years: etiology of SS unknown. Nr.2: 57-year-old man with recurrent vertigo of several hours duration with

dizziness and disequilibrium, without hearing symptomatology. Symptoms appeared several weeks after meningo-encephalitis with subdural empyema. Nr.3: 32-year-old man with progressive bilateral hearing loss since 19 years, dizziness and disequilibrium during the night. Etiology of SS unknown. MRI and neurotological examination were performed, including PTA, BAEP, ENG, c-VEMP, v-HIT.

Neurotological examination showed bilateral hearing loss ( $n = 2$ ), pathological BAEP within all patients. Caloric testing showed left hyporeflexia (cases 2 & 3), right areflexia (case 3); reduced VOR gain of 6 SCC (case 1); no visual suppression of VOR during pendular testing ( $n = 3$ ), normal c-VEMPS both sides ( $n = 3$ ). MRI revealed rims of hypointensity surrounding brainstem, both cochlea-vestibular nerves and typical linear hypointensities into cerebellum ( $n = 3$ ). MRI with SWI ( $n = 2$ ) showed hypointensity in cochlea, sacculus and utriculus of the left ear (case 1).

Within SS, the VIIIth cranial nerve is particularly vulnerable to hemosiderin deposit. MRI findings within cochleo-vestibular nerves, were well correlated with BAEP results also in case of normal hearing. Absence of visual suppression of VOR during pendular testing and unilateral /bilateral hyporeflexia/areflexia at caloric testing, reduced VOR gain within v-HIT corroborated the peripheral and central origin of symptomatology. Sacculocolic reflex seems to be more robust compared to SCC function.

PP088

Motion Sickness and Other Vestibular Disorders

#### **EMBALANCE DATA REPOSITORY MODELING AND CLINICAL APPLICATION**

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Dizziness is a common symptom for both benign and life-threatening disorders with subtle distinguishing features. This poses a clinical challenge for physicians when faced with patients suffering from dizziness and vertigo within primary care. Consequently, patients often get misdiagnosed and inappropriately managed which leads to personal burden on both the patient and health economics. The EU funded EMBalance project aims to develop the first Decision Support System (DSS) that will support not only the clinical decision-making towards accurate and early diagnosis, but also the efficient treatment planning of balance disorders. In this work we present the data mining modeling techniques that have been applied on clinical data to produce a multi-scale, patient-specific balance model that is incorporated in the DSS. Furthermore, we present the clinical proof of concept validation methods and preliminary results by means of multicentred, parallel group, randomised controlled trials. The final outcome of the EMBalance project will be a powerful web-based platform that will be provided to primary and secondary care physicians across specialties, levels of training and geographical boundaries, towards the early diagnostic evaluation, disease course prediction and effective management planning of balance problems.



PP089

Pharmacotherapy

**EFFECTS OF ETHYL LOFLAZEPATE ON SELF-ASSESSMENT OF HANDICAP IN PATIENTS WITH VERTIGO ASSOCIATED WITH SEVERE ANXIETY****Go SATO<sup>1</sup>**, Kazunori MATSUDA<sup>1</sup>, Momoyo MATSUOKA<sup>1</sup>, Noriaki TAKEDA<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Tokushima University, Japan*

Vertigo and dizziness are mainly caused by dysfunction of peripheral and/or central vestibular systems. However, psychiatric disorders such as anxiety sometimes cause vertigo and dizziness. Alternatively, the stress due to vestibular dysfunction may initiate subsequent development of psychiatric disorders such as anxiety and then lead to exacerbation of subjective vertigo and dizziness. If patients are diagnosed as having psychiatric disorders, it is necessary to treat not only vestibular dysfunction but also psychiatric disorders with adequate medication such as anti-anxiety drugs, and/or psychotherapy. In this study, we aimed to elucidate the role of ethyl loflazepate, one of benzodiazepines, in the treatment of dizzy patients with severe anxiety. The present study includes 21 patients treated with ethyl loflazepate and 22 patients treated with difenidol hydrochloride, which is anti-emetic and vertigo drug, for 4 weeks. The anxiety state was evaluated by using State-Trait Anxiety Inventory (STAI), and treatment outcomes were measured with the self-assessment of handicaps in daily life caused by vertigo and dizziness using dizziness and unsteadiness questionnaire. The questionnaire consisted of five factors related to emotional or bodily dysfunction caused by dizziness. In patients with high STAI scores, ethyl loflazepate improved four of five subjective handicap factors as well as state anxiety inventory score at 4 weeks after the start of treatment. In the treatment of dizzy and anxiety patients, ethyl loflazepate is more effective at relieving subjective handicaps caused by dizziness, specifically, in factors of disturbance of social activity, emotion and interpersonal communications compared to difenidol hydrochloride.

PP090

Pharmacotherapy

**THE VESTIBULAR EFFECT OF ISOSORBIDE INTRATYMPANIC INJECTION IN NORMAL RAT****Dongju LEE<sup>1</sup>**, Mi Joo KIM<sup>2</sup>, Nam Beom KIM<sup>3</sup>, **Gyu Cheol HAN<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea*<sup>2</sup>*Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea*<sup>3</sup>*Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea*

**Background:** Vestibular hydrops are considered to be a major patho-mechanism of Meniere's disease. As a treatment agent, loop diuretics are used, but the therapeutic effect remains unclear. In such regards, isosorbide, an osmotic diuretics, is primarily used in cardiogenic pulmonary edema. As sudden dehydration in elderly patients could become a cause of stroke, intratympanic delivery of isosorbide with its 191.14 Da M.W serves as an alternative.

**Methods:** Experiments were performed in 5 healthy Sprague-Dawley rats. All animals received an intratympanic instillation of isosorbide (50 vol %) every day for 7 days at the right side of the ear. The evaluation of vestibular function was measured at pre-treatment day and the last day for treatment by VOR on 0.04, 0.08, 0.16, 0.32 Hz cycle on 100% peak velocity. Furthermore, we tilt the axis for 30° and rotated over 10 cycles to cause step velocity stimulation. From the achieved nystagmus data we made 3D analysis.

**Results:** The gain of treated rats at 7 days was  $0.712 \pm 0.178$ ,  $0.854 \pm 0.114$ ,  $0.882 \pm 0.116$ ,  $0.864 \pm 0.056$  under 0.04–0.08–0.16–0.32 Hz earth vertical rotation stimulations respectively in horizontal nystagmus data. The results were not significant compared to the untreated rats.

**Conclusion:** Intratympanic delivery of isosorbide did not show any significant change in vestibular function. It is reasonable to suppose that high molecular weight of isosorbide inhibits the penetration of labyrinth barrier or that the normal inner ear physiology functions as labyrinth barrier controller.

PP091

Pharmacotherapy

**EFFECT OF SUSTAINED-RELEASE FORM OF 4-AMINOPYRIDINE (FAMPRIDINE) ON PATIENTS WITH DOWN-BEATING NYSTAGMUS****Eduardo MARTIN-SANZ**<sup>1</sup>, Almudena RUEDA<sup>2</sup>, Laura DE TORO<sup>1</sup>, Jonathan ESTEBAN<sup>1</sup>, Ricardo SANZ<sup>1</sup><sup>1</sup>*Department of Otolaryngology, University Hospital of Getafe, Spain*<sup>2</sup>*Department of Neurology, University Hospital of Getafe, Spain***Objective:** To comprehensively assess the effect of sustained-release form of 4-aminopyridine (Fampridine) on patients with down-beating nystagmus.**Methods:** Four patients with Cerebellar ataxia, neuropathy and vestibular areflexia syndrome (CANVAS), a down-beating syndrome and a Multiple Sclerosis patient were treated. After giving written consent, the 6 patients were treated with Fampridine 10 mg, orally twice a day. They were assessed before, 1 and 2 months after treatment. Eye movements with and without visual fixation, slow pursuit and VOR suppression were measured with videonystagmography. Postural imbalance were studied with a computerized dynamic posturography.**Results:** The patients took 20 mg of Fampridine daily for two months without side effects. No significant differences were observed in the down beating nystagmus slow phase velocity between the baseline, 1 and 2-month determinations ( $p > 0.05$ ). No qualitative differences were observed neither in the slow pursuit nor in the VOR suppression. Finally no significant differences were observed in the posturographic scores ( $p > 0.05$ ).**Conclusion:** The sustained-release form of 4-aminopyridine was not effective in controlling the down beating nystagmus and postural imbalance in our population after two months of treatment.

PP092

Spatial Orientation

**HOW ANTEROPOSTERIOR VESTIBULAR INPUT IS PROCESSED IN THE VISUAL CORTEX**Felipe AEDO-JURY<sup>1</sup>, Benoit COTTEREAU<sup>1</sup>, Simona CELEBRINI<sup>1</sup>, **Alexandra SÉVERAC CAUQUIL**<sup>1</sup><sup>1</sup>*Department of Cerco Umr 5549 Cnrs/ups, Université Paul Sabatier, France*

Vestibular and visual signals are the main sensory inputs to the central nervous system during navigation. It is therefore very important to characterize the cortical networks that integrate these multi-sensory signals. Here, we combined Galvanic Vestibular Stimulation (GVS) and functional Magnetic Resonance Imaging (fMRI) to characterize the brain areas activated during locomotion-consistent (i.e. antero-posterior) and inconsistent (i.e. lateral) stimulations in human. We randomly applied 1 mA, 2-s, GVS in four configurations (front, back, left, right) on 13 subjects while recording their BOLD activity in the scanner. We focused our interest in the responses within functionally-defined areas that are strongly activated by egomotion-consistent optic flow patterns: the human middle temporal complex (hMT+), V6, the ventral intraparietal (VIP) area, the cingulate sulcus visual (CSv) area and the posterior-insular cortex (PIC). We found that hMT+, CSv and PIC were significantly responsive during both lateral and antero-posterior GVS with equivalent activations for these two conditions. Area VIP was also activated during both conditions but had significantly stronger responses during the locomotion-consistent one. Interestingly, area V6 was highly activated during locomotion-consistent GVS but remained silent during locomotion-inconsistent GVS. Using psychophysiological interaction (PPI) analyses, we investigated the functional connectivity between these ROIs. It confirmed that a cortical network that specifically includes V6 is engaged during locomotion-consistent GVS. Altogether, our results suggest that V6 has a specific role in processing multisensory signals during navigation, possibly for obstacle avoidance.

PP093

Spatial Orientation

**BASAL DENDRITIC LENGTH REDUCTION IN THE RAT HIPPOCAMPUS AFTER BILATERAL VESTIBULAR LOSS**Sangeeta BALABHADRAPATRUNI<sup>1</sup>, Yiwen ZHENG<sup>1</sup>, Ruth NAPPER<sup>2</sup>, **Paul F SMITH**<sup>1</sup><sup>1</sup>*Department of Pharmacology And Toxicology And the Brain Health Research Centre, School of Medical Sciences, University of Otago Medical School, Dunedin, New Zealand*

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Some previous studies in humans have shown that bilateral loss of vestibular function is associated with a significant bilateral atrophy of the hippocampus, which correlated with the patients' spatial memory deficits. By contrast, studies in rats have failed to detect any changes in hippocampal volume following bilateral vestibular loss. Therefore, in this study we investigated whether bilateral vestibular deafferentation (BVD) might result in more subtle morphological changes in the rat hippocampus, involving alterations in dendritic intersections, using Golgi staining and Sholl analysis. We found that at 1 month following surgical BVD ( $n = 8$ ), there was a significant decrease in basal ( $P \leq 0.0001$ ), but not apical, dendritic intersections in the CA1 region of the hippocampus compared to sham-operated animals ( $n = 8$ ) and anaesthetic controls ( $n = 7$ ), indicative of a decrease in basal dendritic length. There was, however, no significant difference between the sham-operated animals and anaesthetic controls. By contrast, dendritic branching was not significantly affected. These results suggest that the rat hippocampus does undergo subtle morphological changes following bilateral vestibular loss, but that they may be in the form of alterations in dendritic structure.

PP094

Superior Canal Dehiscence Syndrome

**A CASE REPORT OF SUPERIOR CANAL DEHISCENCE SYNDROME MANIFESTED AS MENIERE'S DISEASE.**

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Superior semicircular canal dehiscence is characterized by vestibular symptoms provoked by sound and pressure stimuli and audiologic symptoms including autophony, hyperacusis and ear fullness. The typical audiologic feature of superior semicircular canal dehiscence is known as conductive hearing loss at low frequency, characterized by decreased bone-conduction sound threshold in audiometry. Meniere disease is defined as "recurrent, spontaneous episodic vertigo; hearing loss; aural fullness; and tinnitus. Typical hearing loss in Meniere disease is sensorineural hearing loss at low frequencies. The hearing may fluctuate during the clinical course of the disease. We report a 52-year-old male presented with unilateral mixed hearing loss, with fluctuation of hearing impairment and repeated spinning type vertigo. High resolution temporal bone computed tomography revealed superior canal dehiscence on the affected site of hearing. This case informed superior canal dehiscence can accompany with Meniere disease and the fluctuation of hearing differentiates between these two disease.

PP095

Superior Canal Dehiscence Syndrome

**A COMPARISON OF SURGICAL TREATMENTS FOR SUPERIOR SEMICIRCULAR CANAL DEHISCENCE: A SYSTEMATIC REVIEW**

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**Objective:** We investigate the post-operative subjective and objective outcomes of different surgical treatments for superior semicircular canal dehiscence (SSCD): vestibular signs, auditory signs, vestibular evoked myogenic potential test, pure tone audiogram, speech audiogram or video-nystagmography. Data sources: Systematic review using the Pubmed, Cochrane Library and Embase.

**Review methods:** A systematic search was conducted. Only original studies reporting pre- and post-operative subjective and/or objective outcomes of surgical treatment for SSCD were included. The pre- and post-operative outcomes of surgical techniques and approaches were extracted.

**Results:** In total, 819 unique articles were retrieved. Thirty-four studies were included for quality assessment. The pre- and post-operative outcomes of different surgical treatments for SSCD were extracted from 24 studies. In the

available studies, plugging through Middle Fossa Approach (MFA) or Transmastoid Approach (TMA) was mostly performed. Both treatments for SSCD gives similar subjective and objective outcomes. The hospital stay was longer and the report of adverse events were higher in the patients plugged through MFA.

**Conclusion and Recommendation:** Surgical treatment for SSCD is particularly effective for vestibular symptoms and there is no evidence for improvement of hearing loss after surgical treatment. Since plugging using TMA had a lower complication rate, lower revision rate and a shorter hospital stay, this treatment is recommended in high disabled SSCD patients.

PP096

Traumatic Brain Injury

### **CHRONIC POST-TBI DIZZINESS RELATE TO MULTIPLE DIAGNOSES COMBINING PERIPHERAL AND CENTRAL VESTIBULAR DYSFUNCTION**

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**Objective:** We hypothesised that chronic vestibular symptoms (CVS) of imbalance and dizziness post-traumatic head injury (THI) may relate to: (i) the occurrence of multiple simultaneous vestibular diagnoses including both peripheral and central vestibular dysfunction in individual patients increasing the chance of missed diagnoses and suboptimal treatment; (ii) an impaired response to vestibular rehabilitation since the central mechanisms that mediate rehabilitation-related brain plasticity may themselves be disrupted.

**Methods:** We report the results of a retrospective analysis of the comprehensive clinical and vestibular laboratory testing in 20 consecutive THI patients with prominent and persisting vestibular symptoms who were assessed on average 6 months post THI.

**Results:** Individual THI patients typically had multiple vestibular diagnoses and unique to this group of vestibular patients, often displayed both peripheral and central vestibular dysfunction. Following expert neuro-otological management, at two years 20% of patients still had persisting vestibular symptoms.

**Conclusion:** In summary, chronic vestibular dysfunction in THI could relate to: (i) the presence of multiple vestibular diagnoses, increasing the risk of 'missed' vestibular diagnoses leading to persisting symptoms; (ii) the impact of brain trauma which may impair brain plasticity mediated repair mechanisms. Apart from alerting physicians to the potential for multiple vestibular diagnoses in THI, future work to identify the specific deficits in brain function mediating poor recovery from post-THI vestibular dysfunction could provide the rationale for developing new therapy for head injury patients whose vestibular symptoms are resistant to treatment.

PP097

Vascular Vertigo

### **DIAGNOSTIC VALUES OF CT, MRI AND MRA IN ASSESSMENT OF POSTERIOR CIRCULATION ISCHEMIA VERTIGO**

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**Objective:** To assess the values of CT, MRI and MRA in posterior circulation ischemia vertigo (PCIV) diagnosis. **METHODS** The imaging data of 32 patients with vertigo, which included the results of CT, MRI and MRA using GE Light Speed 4 or 16 layers MSCT scanner or Signa Excite HD 3.0T high field MR scanner, were studied. **RESULTS** Significant difference between the results of CT and MRI ( $\chi^2 = 14.076$ ,  $P = 0.000$ ) were detected in this study. 11 cases with cerebral infarction were made the CT and MRI inspection in the 24 hours, and the results of CT and MRI consists significant difference ( $\chi^2 = 12.034$ ,  $P = 0.001$ ). MRA test results showed that the type of arteria vertebralis included 34 cases of type A, 5 cases of type B, 7 of type C and 7 of type D. 2 cases showed the common features of type B and C, 6 cases showed the common features of type A and B, as well as 3 cases showed no abnormalities. The morphology of arteria basilaris showed that, 22 cases accorded with type A, 3 of type B and 3 of type C. 2 cases showed the common features of type A and B as well as 2 cases showed no abnormalities.

**Conclusion:** The magnetic resonance plays an important roles in the clinical diagnosis, prognosis and the estimated treatment plan choice of the PCIV.

PP099

Vestibular and Inner Ear Physiology

### **CHOLINERGIC RESPONSES IN CONTROL AND ALPHA-9 SUBUNIT KNOCKOUT MICE**

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**Background:** The mammalian peripheral efferent vestibular system (EVS) uses acetylcholine (ACh) as a fast neurotransmitter. However, the mechanisms that underlie cholinergic EVS activation remain unclear. We used our semi-intact preparation of mouse vestibular organs in control and alpha-9 nicotinic receptor subunit ( $\alpha 9$ nAChR) knock out mice to investigate the EVS.

**Methods:** Horizontal and anterior cristae and utricle were used for patch clamp recordings of hair cells and calyx afferent terminals. Short duration ACh (100 ms; 100–300  $\mu$ M) evoked cholinergic responses. Antagonists were used to block  $\alpha 9$ nAChRs, calcium-activated potassium channels (SK), and alpha4-beta2 containing nAChRs ( $\alpha 4\beta 2$  nAChRs). Capacitance recordings and immunolabelling were also done.

**Results:** Type II hair cells exposed to ACh in control mice resulted in a biphasic current response that was sensitive to apamin and strychnine. This ACh response was absent in alpha-9 KO mice. An inward current was also identified in calyx terminals from both control and alpha-9 KO mice suggesting a possible role for  $\alpha 4\beta 2$  nAChRs. Type II hair cell capacitance measurements suggest an increase in neurotransmitter release, even at hyperpolarized potentials in response to ACh application. Immunofluorescent labelling indicated a slight difference in size but not number of efferent terminals between control and alpha-9 KO mice.

**Conclusions:** Type II hair cells are inhibited by ACh via activation of  $\alpha 9$ nAChRs and SK channels. However, despite being inhibited, type II hair cells may still excite afferents by releasing neurotransmitter in response to ACh. These results reconcile two previously contradictory EVS observations; hair cell inhibition, and afferent excitation.

PP100

Vestibular and Inner Ear Physiology

### **HOW OTOLITH ORGANS WORK**

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This paper describes the functional anatomy of the otolith organs. Emphasized are:

1. The difference in size of the otoconia over the striola compared to the peripheral macula, results in inertial differences causing perilymph flow, stimulating the vestibular hair cells.
2. Separation of whole body movement from head movement is determined by differential activity of the most dynamically active parts of the striola in any movement which is where it is at right angles to the movement. Because of the curved nature of the striola of the utricle and saccule each macula has two points of maximal response for any movement. If responses are equal this means that there is a movement of the head in a single plane, probably as part of a whole body movement, and if there is a difference in response between the two sites in each macula this indicates that there is a rotational movement.
3. The kinocilium has at its base contractile protein. With a planned movement vestibular efferent preprogramming results in kinociliary movement to maintain a constant distance between the otolithic membrane and the hair cells, enhancing perilymph flow and hair cell activation.

4. The saccule has as its main function detection of vertical movement of head and body. This includes damping of the heel strike. The utricle deals largely with horizontal movement, looking around. Preprogrammed efferent vestibular activity via kinociliary tonic contraction suppresses heel strike vibration in both the maculae of the saccule and utricle.

PP101

Vestibular and Inner Ear Physiology

**LINEAR TRANSMISSION OF NEURAL INFORMATION BETWEEN AFFERENT NEURONS AND VESTIBULAR NUCLEI**

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The neural information of vestibular reflexes between afferent neurons and vestibular nuclei (VN) has been traditionally believed to be linearly transmitted. However, this view is challenged by the efficient neural representation in the central nervous system. Here, we investigated the linear transmission of neural information between the afferent neurons and VN, using a combined stimulus with head rotation and galvanic vestibular stimulation (GVS). Twenty six (15 regular and 11 irregular units) responses from twenty healthy guinea pigs were used for this study. Following anesthesia, the animal's head was fixed in a stereotaxic apparatus, and loaded on top of a horizontally rotatory table. For extracellular neural recording in VN, the animal's cranium was exposed, and a hole was made above an estimated VN location. The neuronal response were tested in four separated stages; a resting, a pure horizontal head rotation, a pure GVS and a combined stimulus of GVS and horizontal head rotation. We separately curve-fitted a sine wave on the neuronal response of each stimulus stage. The linearity was examined by comparing the amplitudes and baselines of the curve-fitted waves (the principle of superposition). The difference between two baselines during pure rotation and combined stimulus indicated the neural information is transmitted with depression, but the linearity of neural information was maintained between afferent neurons and VN.

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PP102

Vestibular Compensation and Rehabilitation

**EFFECT OF KOREAN RED GINSENG ON EARLY VESTIBULAR FUNCTION RESTORATION AFTER UNILATERAL LABYRINTHECTOMY**

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**Background:** No medications have been discovered that enhance vestibular functional restoration. The current study was conducted to evaluate the ability of ordinary Korean Red Ginseng (KRG) to induce vestibular compensation by vestibule-ocular reflex.

**Methods:** Five Sprague-Dawley rats were fed KRG extract (100 mg/kg) for 2 wk before undergoing unilateral labyrinthectomy (ULx.). The seven rats were untreated before ULx. After surgery, all animals were housed in the same environment without being fed additional extract. To evaluate vestibule function, gain of the horizontal nystagmus to 0.2 Hz with a peak velocity of 100 deg/s sinusoidal rotation was compared and analyzed before ULx. as well as 3 and 7 d after surgery. In addition, to investigate on the treatment effect, KRG extract was fed after ULx. for 7 post-operation days and compared equally.

**Results:** Before the ULx., gain of the control and KRG group were  $0.81 \pm 0.05$  and  $0.88 \pm 0.08$ , respectively. This value decreased to  $0.43 \pm 0.08$  and  $0.53 \pm 0.08$ , respectively on 3 d after operation ( $p = 0.047$ ), and it was  $0.40 \pm 0.06$  and  $0.68 \pm 0.11$ , respectively on 7 d after surgery. The difference of gain between the two groups was statistically significant at each 3 and 7 d ( $p < 0.05$ ). We confirmed functional vestibular modulated effect of KRG through c-Fos protein expression in medial vestibular nuclei.

**Conclusion:** Rats treated with KRG showed more rapid recovery after acute vestibular loss compared to untreated animals. Although, its ability as a post-operational treatment method was not significant.

PP103

Vestibular Compensation and Rehabilitation

### MEASURES OF FALLS, STATIC AND DYNAMIC BALANCE IN INDEPENDENT OLDER ADULTS IN CAPE TOWN, SOUTH AFRICA

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**Background and Purpose:** Falls are a global problem with an impact on individuals in terms of morbidity and mortality. There is a sizeable evidence base regarding the high prevalence of falls in developed countries; but less so in developing countries since falls prevention and management are not considered a priority due to the high prevalence of communicable diseases. Imbalance is the primary risk factor for falls. **Aims:** (i) to describe performance on static and dynamic balance tests, in independent community-dwelling adults aged 40 years and above, (ii) to identify any associations between falls and fall risk factors and results from the tests of static and dynamic balance and (iii) to establish the occurrence and severity of self-reported falls.

**Method:** A survey and correlational study was conducted. Participants ( $N = 150$ ) completed a test of static (mCTSIB) and dynamic (TUG) balance.

**Results:** The occurrence of falls was 40%. Of those who had reported a fall, 85% sustained an injurious fall. As expected, increased age  $> 60$  years was associated with increased TUG scores for all three variations. Males typically performed better than females in all three TUG tests. Participants  $> 80$  years had the most difficulty maintaining the mCTSIB conditions 2–4. Risk factors associated with falls included sex ( $p = 0.013002$ ), unsteadiness when walking ( $p = 0.03063$ ), fear of falling ( $p = 0.03396$ ) and medication ( $p = 0.02289$ ), particularly sedatives ( $p = 0.01822$ ) and anti-depressants ( $p = 0.01005$ ).

**Conclusion:** At least for some sectors of the South African population, falls are regular occurrences.

PP104

Vestibular Compensation and Rehabilitation

### A NEW METHOD TO IMPROVE THE IMBALANCE IN CHRONIC UNILATERAL VESTIBULAR LOSS: THE ORGANIZATION OF REFIXATION SACCADES

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**Objective:** to test that the temporary grouping of refixation saccades should be linked to a better clinical status without gain recovery.

**Methods:** a training to induce the refixation saccades into a gathered fashion is performed in a dark room. The outcome measures are the handicap level measured by the dizziness handicap index (DHI) and the refixation saccades organization pattern measured by a numeric score called 'PR' given by a software developed by the authors. We analyse before the training and one and three months after ending, Non-parametric tests were used for statistical analysis.

**Results:** we have included 10 healthy subjects (4 males and 6 females) and 16 patients with chronic unsteadiness due to unilateral vestibular loss (9 vestibular neuritis, 4 postsurgical vestibular schwannoma and 3 cases after intratympanic gentamycin in patients with Ménière's disease). The reduction in the DHI score from its pre-treatment value was significant at one ( $p = 0.028$ ) and three months ( $p = 0.042$ ) post-treatment. And we also found statistically significant differences between the PR score before the procedure and PR score one ( $p = 0.005$ ) and three months after the treatment ( $p = 0.003$ ).

**Conclusion:** the vestibulo-ocular reflex (VOR) adaptation and the organization of the refixation saccades in a gathered pattern is a process that can be artificially induced in patients with unilateral vestibular loss (UVL) who have not developed it naturally, improving imbalance symptoms and vestibular disability.

PP105

Vestibular Compensation and Rehabilitation

### TRANSLATION AND VALIDITY OF THE THAI VERSION OF THE DIZZINESS HANDICAP INVENTORY

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Dizziness and disequilibrium are two common chief complaints in patients with vestibular dysfunction. Patients with failure of compensation or vestibular de-compensation experience chronic dizziness which significantly affects on their quality of life. The Dizziness handicap inventory (DHI) is a self-perceived questionnaire to quantify its impact on daily living activities. The objectives of this study were to translate the Dizziness Handicap Inventory into Thai (DHI-T) and to evaluate its internal consistency and convergent validity.

**Methods:** Forty-two patients (15 men and 27 women with mean age of  $55.5 \pm 12.23$  years old) with at least 6 months of dizziness due to vestibular disorders were assessed using both DHI-T and Thai Short Form-36 Health Survey (SF-36 Thai v.2). The Cronbach's alpha was used to examine the internal consistency. The correlations between DHI-T and SF-36 Thai were estimated by Spearman's rank correlation coefficients.

**Results:** The DHI-T shows good internal consistency. The Cronbach's alpha for the total score, functional, physical and emotional subscales were 0.921, 0.821, 0.745 and 0.840, respectively. The total score of DHI-T was highly correlated with the social functioning subscale of the SF-36 ( $-0.569$ ) and moderately correlated with the rest of SF-36 subscales.

**Conclusion:** The DHI-T demonstrated high internal consistency. It is a valid tool to quantify the impact of chronic dizziness on quality of life in Thai population.

PP106

Vestibular Migraine

### REDUCTION OF MIGRAINE EPISODES IN A SUBSET MENIERE PATIENTS WITH CHRONIC USE OF WABIPS

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The use of Weak Asymmetric Base-in Prism spectacles (WABIPS) developed by Utermöhlen in 1941 is a non-invasive treatment of Ménière vertigo (FP-0158) with high tolerability and patient satisfaction, also reported to be effective against motion sickness. We evaluated this treatment in a cohort study of 336 unilateral definite Ménière (MD) patients (according to AAS) with 97% subjective satisfaction and reduction of vertigo symptomatology and 57% significant reduction and stopped concomitant medication. We also found in a subset group that before treatment 137 patients (40.8% (49.3% woman, 27.1% men) with MD also had Migraine episodes (according to IHS). After 12 months treatment only 59 (17.6%) still had migraine episodes indicating a significant reduction of episodes. Migraine prevalence is 17%. Analyzed by the McNemar test for statistically significant changes if the chi-square



(X2) = 69.65, difference = 1,  $p < 0.0001$ . This confirms that Ménière and Migraine constitute a heterogeneous population, probably Vestibular Migraine (VM) with sensitivity to visual motion. Data also shows that this group can be positively influenced by visual factors like by WABIPS which have consequences for dynamic visual images as it reduces stressful visual stimulation that can result in oscillopsia. Whether the (ocular) re-afferent signals are modified with WABIPS is yet not known. Studies including WABIPS in VM with visual vertigo should be a serious next step.

PP107

Vestibular Migraine

### COMPARISON OF AUDIOLOGICAL FINDINGS IN PATIENTS WITH VESTIBULAR MIGRAINE AND MIGRAINE AND HEALTHY CONTROLS

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We investigated audiological findings in 50 vestibular migraine (VM) and 31 migraine without history of vertigo (MO) patients and 52 healthy controls in an interdisciplinary prospective cross sectional study. All participants underwent a detailed otological examination followed by full audiological investigation. Before audiological evaluation, a detailed medical and otological history, including presence and fluctuation of hearing loss, tinnitus, vertigo, and the relationship of headache and vertigo were taken. Audiological tests included pure tone audiometry, speech reception threshold, speech discrimination score and acoustic immittance. Air conduction hearing thresholds were detected in frequencies between 250–8000 Hz, bone conduction hearing thresholds were detected in frequencies between 500–4000 Hz for pure tone audiometry, speech reception thresholds and speech discrimination scores were determined (Interacoustics AC 40 Clinical Audiometer, Assens, Denmark). Acoustic immittance tests were performed to all patients (Interacoustics AZ 7 Immittancemeter Assens, Denmark). Patients who had abnormal acoustic immittance findings were excluded. All data were analysed statistically using SPSS 20.0 and p value of  $< 0.001$  was accepted as a significance level. Our results showed that there were not any significant difference between speech discrimination and speech reception threshold scores between three groups. Nineteen patients had tinnitus in VM group and 4 patients had mild to moderate sensorineural hearing loss which started simultaneously with VM in various degrees. Our results are consistent with the results of the limited number of previous studies. In addition, the design of our study is unique comparing VM with not only healthy controls but MO patients.

PP108

Vestibular Migraine

### COGNITIVE AND PSYCHIATRIC COMORBIDITIES IN PATIENTS WITH VESTIBULAR MIGRAINE

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**Objective:** This study investigated the prevalence of psychiatric, cognitive and fatigue disturbances in a sample of 100 patients with vestibular migraine. The nature of this relationship and the variables influencing it were also explored.

**Background:** This research adds to an emerging body of evidence (gathered by a variety of clinical and laboratory approaches) that has demonstrated that the human vestibular system not only regulates autonomic activity, but also influences processes associated with cognition and affect. This study will be the first to assess a broad range of higher level functions in patients with vestibular migraine.

**Methods:** A comprehensive neuropsychological assessment battery was administered, including measures of depression, anxiety, depersonalisation, fatigue, sleep, memory, attention and executive function. Neurological questionnaires and balance function tests were also administered.

**Results:** Unexpectedly, nearly all patients showed evidence of clinical impairment on most tests. Symptoms of fatigue, anxiety and working memory impairment were especially prevalent in the sample (over 50% fell outside

the normative cut-off). Age, visual dominance, and previous access of psychological support were all significant predictors of the presence of these comorbidities.

**Conclusions:** These findings suggest that the vestibular system exerts a much wider influence on cognition and affect than previously indicated, and underlines the need for broader clinical diagnosis, assessment and management in patients who present with balance complaints.

PP109

Vestibular Neuritis

### STATISTICAL REPORT ON HOSPITALIZED CASES OF VESTIBULAR NEURITIS

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**Objective:** To investigate the background of hospitalized patients with vestibular neuritis within a period of ten years.

**Methods:** A retrospective study was conducted of the medical records of patients with vestibular neuritis who were hospitalized in our hospital between January 2001 and December 2010.

**Results:** 49 cases were hospitalized during this period. The study population was 44.9% male and 55.1% female. The average age of patients was  $58.6 \pm 14.2$  (range 22–82) years old. Age distribution showed a peak at 60 years old. The proportion of 65 years and older was 34.7%. There was no significant difference in the length of hospitalization between under 65 y.o. and 65-and-over. The high onset season was spring and summer but there were no significant differences. The duration of the spontaneous nystagmus, the symptoms of dizziness and of the bed rest were  $5.5 \pm 2.2$ ,  $3.0 \pm 1.5$  and  $3.8 \pm 1.5$  days respectively. Enhanced regions of the vestibular nerves were not detected in the 16 cases of those who were examined by the gadolinium (Gd)-enhanced MRI. The number of cases with preceding upper respiratory infections were 7 cases.

**Conclusion:** In this study, there was not a trend of aging in hospitalized patients with vestibular neuritis. The number of cases who had preceding upper respiratory infections were small. The enhanced regions were not detected by Gd-enhanced MRI in all cases. It is useful to investigate the background of hospitalized patients in order to understand the pathology of vestibular neuritis.

PP110

Vestibular Neuritis

### ASSESSMENTS OF NEUTROPHIL/LYMPHOCYTE AND PLATELET/LYMPHOCYTE RATIO AND PLATELET INDICES IN VESTIBULAR NEURITIS

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**Objective/Hypothesis:** To assessment of the correlations neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR) and platelet indices as biomarkers in patients with vestibular neuritis.

**Study Design:** Retrospective, case-control study.

**Methods:** 99 patients who were diagnosis with vestibular neuritis and one hundred five age- and sex-matched healthy controls were compared. Clinical information and complete blood cell count were checked and analyzed. NLR and PLR were calculated with neutrophil, platelet and lymphocyte count.

**Results:** Both mean NLR and PLR values of the patients were significantly higher than the control group ( $P < 0.001$ ,  $P = 0.008$ ). Mean platelet volume (MPV) was lower than the control group. White blood cell (WBC) and NLR were statistically significant predictors in patients with vestibular neuritis (odds ratio = 1.795,  $P < 0.001$ ); (odds ratio = 1.466,  $p = 0.023$ ). The duration of nystagmus was not significantly correlation with NLR and PLR. Additionally we checked NLR of 23 patients among total 99 patients again on 3rd hospital day. But repeated measure ANOVA of these patients was not statistically significant ( $P > 0.05$ ).

**Conclusions:** Higher NLR, PLR were significantly associated with vestibular neuritis. NLR above the reference range of a facility will be a useful indicator of vestibular neuritis. Platelet indices may not be considered as a predictive marker of vestibular neuritis. During hospitalization, follow-up NLR in the same patient seems to be reduced, however did not show statistical significance.

PP111

Vestibular Neuritis

**ASSESSMENT OF VESTIBULAR RECOVERY USING VIDEO HEAD IMPULSE TEST IN VESTIBULAR NEURITIS**Jun-Hyun KIM<sup>1</sup>, Tae-Kyeong LEE<sup>1</sup>, Ho-Sik SHIN<sup>1</sup>, Ki-Bum SUNG<sup>1</sup><sup>1</sup>*Department of Neurology, Bucheon Hospital, Soonchunhyang University College of Medicine, Korea*

**Purpose:** Recovery from vestibular neuritis (VN) shows various clinical course and some patients complain chronic dizziness. The video head impulse test (vHIT) is the novel method for evaluation of high frequency vestibulo-ocular reflex (VOR). The study is purposed to identify chronic VOR dysfunction with vHIT.

**Methods:** Serially admitted 78 patients with VN are included. Subjective vertigo, nystagmus, and video head impulse test were recorded until discharged (1–8 days) and at 1 week, 1, 3, 6 months follow-up after discharge. Other vestibular function tests are performed during admission. Recovery of vHIT is defined as ipsilateral horizontal canal gain > 0.8 at 30 days after symptom onset.

**Results:** Recovery pattern were identified in 54 patients. (29 unimpaired, 15 recovered, 9 unrecovered). Mean vHIT gain was 0.28 (unrecovered), 0.62 (unimpaired), 1.02 (recovered). vHIT gain was improved at first week in 12 out of 15 patients. There were association of initial vHIT gain with other vestibular function tests. VOR gain on rotary chair test showed significant correlation with vHIT gain in 0.01–0.64 Hz. More impairment in caloric test, subjective visual vertical, ocular torsion angle were found in lower vHIT gain. Ipsilateral ocular VEMP was more affected in unrecovered vHIT patients. Residual dizziness after discharge were more common in unrecovered vHIT patients. ( $p = 0.004$  at 1 week,  $p = 0.007$  at 3 months).

**Conclusion:** The vHIT test is useful tool for prediction of chronic VOR dysfunction and residual dizziness after VN.

PP112

Vestibular Prosthesis

**EFFECTS OF LOCALIZING STIMULATION FROM A VESTIBULAR PROSTHESIS**Christopher PHILLIPS<sup>1</sup>, Leo LING<sup>1,3</sup>, Kaibao NIE<sup>1</sup>, Amy NOWACK<sup>1</sup>, Jay T RUBINSTEIN<sup>1,2</sup>,**James O PHILLIPS<sup>1,3</sup>**<sup>1</sup>*Department of Otolaryngology-hns, University of Washington, USA*<sup>2</sup>*Department of Bioengineering, University of Washington, USA*<sup>3</sup>*Department of Washington National Primate Research Center, University of Washington, USA*

**Background:** Vestibular prostheses are under investigation in both animal models and human subjects. Such devices elicit eye movements comparable to those produced naturally through the vestibulo-ocular reflex (VOR). However, current spread within and beyond the labyrinth limits the precision of stimulation. We evaluated the efficacy of localized stimulation between electrodes implanted within a single semicircular canal (SCC) and in two adjacent SCCs.

**Methods:** Human Meniere's patients and rhesus monkeys were implanted unilaterally with identical multichannel vestibular neurostimulators. Eye movements were recorded with 2D scleral coils or VOG, in response to stimulation delivered to individual SCC ampullae with a return either to a remote ground outside of the labyrinth, an electrode in an adjacent SCC, or an electrode within the same SCC.

**Results:** Stimulation elicit eye movements predominantly in the direction expected from the SCC stimulated but with significant off-direction components and activation of the facial nerve at higher currents. Stimulation between two adjacent canals typically reduced the off-plane components and greatly increased the current threshold for activation of the facial nerve. Stimulation between two electrodes in the same canal reduced off plane components, but increased the current threshold for eliciting eye movements.

**Conclusions:** Current localization by these methods limits current spread to tissues within and outside the labyrinth, resulting in greater stimulation efficacy, as reflected in the direction of elicited eye movements and increase in facial nerve threshold. However, as expected, this method increased the threshold for eliciting eye movements.

**Funding:** NIDCD, NCR-ORIP, Cochlear Ltd, Wallace H. Coulter Foundation.

PP113

Clinical Testing for Vestibular Function

**CLINICAL FEASIBILITY OF VIDEO HEAD IMPULSE TEST IN DIAGNOSIS OF BENIGN PAROXYSMAL POSITIONAL VERTIGO****Beomcho JUN<sup>1</sup>**, Eunhye SHIN<sup>1</sup>, Sunil LYU<sup>1</sup>, Kihong CHANG<sup>1</sup>, Sangwon YEO<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Uijeongbu St. Mary's Hospital, The Catholic University of Korea, Korea*

**Object:** Both video ENG and video HIT are widely used clinical tool in diagnosis of vestibulopathy such as Meniere's disease, benign paroxysmal positional vertigo, Vestibular neuritis. Video ENG give us a hint of possibility of paroxysmal vertigo by otolith using positioning or positional test. However, not all the patients who are suspicious of BPPV were detecting in physical exam or video ENG. The aim of this study is evaluate of clinical feasibility of vHIT in detect the abnormal findings in patient who clinically diagnosed of BPPV.

**Method:** Ten patients who were diagnosed of BPPV by physical exam or video ENG were performed vHIT before repositioning methods. The vestibulo-ocular reflex was evaluated using a video system (vHIT; GN, Otometrics, Taastrup, Denmark). Control group were included the patient of vestibular neuritis, Meniere disease, sudden deaf, tumor with dizziness. The gain and abnormal saccade of VOR were evaluated

**Results:** Only the four of the ten patients of clinically suspected BPPV shows the abnormal gain and hint of abnormal saccades or nystagmus. Lateral canal BPPV more sensitive to find abnormal gain in hVOR in vHIT. vHIT has a limitation in diagnosis of BPPV by otolith by its latency in manifestation of symptoms. However, it has the complementary function to evaluating positional or positioning vertigo together with video ENG.

**Conclusion:** Video HIT might support the diagnosis of clinically detect BPPV by otolith. Additional advantage of vHIT were evaluate separate the six canal with high frequency stimulus which might evoke the positional vertigo.

PP114

Animal Models and Molecular Approach

**BILIRUBIN-INDUCED CA<sup>2+</sup> OVERLOAD OF DEVELOPING AUDITORY NEURONS BY P/Q-TYPE VOLTAGE-GATED CALCIUM CHANNELS****Min LIANG<sup>1</sup>**, **Shan Kai YIN<sup>1</sup>**, **Lu Yang WANG<sup>2</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, China*<sup>2</sup>*Department of Physiology, Programs In Neurosciences & Mental Health, Sickkids Research Institute And Department of Physiology, University of Toronto, Canada*

Pathological levels of bilirubin can elevate intracellular Ca<sup>2+</sup> level, which may underlie Ca<sup>2+</sup> overload and neuronal toxicity during early neonatal stage. However, how voltage-gated calcium channels (VGCCs) are functionally involved in excess calcium influx remains elusive. Here, we performed voltage-clamp recordings from bushy cells in the ventral cochlear nucleus (VCN) of brainstem slices in postnatal rat pups (P4-17) to investigate developmental changes in VGCC subtypes and their potential participation in bilirubin-induced Ca<sup>2+</sup> overload. We found the total current density mediated by VGCCs was more than doubled over P4-17, but the weight of each VGCC subtype as dissected by specific blockers changed dramatically, being relatively equal among T, L, N, P/Q and R-type at P4-6 to predominantly L, N, R over T and P/Q at P15-17. Acute administration of bilirubin increased the whole-cell VGCC currents, especially high voltage-activated (HVA) calcium currents. Blockade of P/Q-type calcium channels by the specific antagonist  $\omega$ -Agatoxin IVA or intracellular Ca<sup>2+</sup> buffer EGTA significantly attenuated bilirubin-induced increase in calcium currents and total calcium integrals by pseudo action potentials. In contrast, blockers for L- and N-type channels had little effect. These findings indicate that acute exposure to bilirubin augments VGCC currents, primarily by targeting P/Q-type calcium channels, potentially overwhelming neurons with excessive Ca<sup>2+</sup>. Since P/Q-subtype calcium channels is more prominent in neonatal neurons (e.g. P4-6) than later stages, we suggest this subtype-specific enhancement of P/Q-type Ca<sup>2+</sup> currents likely contributes to their vulnerability to the neurotoxicity associated with hyperbilirubinemia in auditory and other brain regions during early development.

PP115

Animal Models and Molecular Approach

**EXAMINATION OF THE VESTIBULAR COMPENSATION IN THE RAT BY THE FOS-POSITIVE NEURONAL PATTERN OF MANIFESTATION**Kazunori MATSUDA<sup>1</sup>, Tadashi KITAHARA<sup>2</sup>, Go SATO<sup>1</sup>, Noriaki TAKEDA<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Institute of Biomedical Science, Tokushima University Graduate School,, Japan*<sup>2</sup>*Department of Otolaryngology And Head And Neck Surgery, Nara Medical University, Japan*

Perverted nystagmus and the dysequilibrium to occur after vestibular disorder of the unilateral inner ear are gradually relieved by a time course, and this phenomenon is called vestibular compensation.

The vestibular compensation is distributed between static vestibular compensation and dynamic vestibular compensation. Whereas static vestibular compensation is inhibited when we give MK801 which is a glutamatergic NMDA receptor blocker in an initial process of the static vestibular compensation, and dysequilibrium aggravates it again, and this is called with de-compensation.

We found that a Fos-positive neuron appeared to the medial vestibular nucleus of the healthy side when we gave MK801 to a rat after the unilateral inner ear destruction and could visualize the neuron of the medial vestibular nucleus of the healthy side inhibited through cerebellum in a process for early days of the static vestibular compensation, and we proved that it was an index of the progress of the static vestibule compensation so far. However, there is not the report that examined completion time of the vestibular compensation in the rat definitely so far. We cause de-compensation to a rat after Unilateral Labyrinthectomy, and report it because we examined completion time of the static vestibular compensation in the rat from Fos-positive neuronal change over time to appear to the nystagmus and healthy side medial vestibular nucleus which are sometimes found.

PP116

Animal Models and Molecular Approach

**5-HT3 RECEPTOR EXPRESSION IN THE MOUSE VESTIBULAR GANGLION**Yasumitsu TAKIMOTO<sup>1,2,3</sup>, Yusuke ISIDA<sup>2</sup>, Takao IMAI<sup>1</sup>, Makoto KONDO<sup>2</sup>, Yukiko NAKAMURA<sup>2</sup>, Suzuyo OKAZAKI<sup>1</sup>, Tomoko OKUMURA<sup>1</sup>, Hidenori INOHARA<sup>1</sup>, Shoichi SHIMADA<sup>2</sup><sup>1</sup>*Department of Otorhinolaryngology – Head And Neck Surgery, Osaka University Graduate School of Medicine, Japan*<sup>2</sup>*Department of Neuroscience And Cell Biology, Osaka University Graduate School of Medicine, Japan*<sup>3</sup>*Department of Otorhinolaryngology, Suita Municipal Hospital, Japan*

The 5-hydroxytryptamine type 3 (5-HT3) receptor is a ligand-gated ion channel and a member of the Cys-loop family of receptors. Previous studies have shown 5-HT3 receptor expression in various neural cells of the central and peripheral nervous systems. Although the function and distribution of the 5-HT3 receptor has been well established, its role in the inner ear is still poorly understood. Moreover, no study has yet determined its localization and function in the peripheral vestibular nervous system. In the present study, we reveal mRNA expression of both 5-HT3A and 5-HT3B receptor subunits in the mouse vestibular ganglion (VG) by RT-PCR and in situ hybridization (ISH). We also revealed nerve terminals of 5-HT3A receptor positive cell are located in the vestibular hair cells by immunostaining using 5-HT3A-EGFP transgenic mice. Moreover, we performed Ca<sup>2+</sup> imaging to determine whether functional 5-HT3 receptors are present in the mouse VG, using a selective 5-HT3 receptor agonist, SR57227A. In wild mice, 32% of VG neurons responded to the agonist, whereas there was no response in 5-HT3A receptor knockout (KO) mice. Lastly, we determined vestibular functions of 5-HT3A receptor KO mice using both behavioral test and vestibulo-ocular reflex (VOR) test. These results indicate that VG cells express functional 5-HT3 receptor channels and might play a modulatory role in the peripheral vestibular nervous system.

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Animal Models and Molecular Approach

**EVIDENCE AND MAIN SITE OF ATP SECRETION IN THE VESTIBULAR SYSTEM BY MECHANICAL STIMULATION**Jeon Mi LEE<sup>1</sup>, Jin Young KIM<sup>2</sup>, Jae Young CHOI<sup>1</sup>, Sung Huhn KIM<sup>1</sup><sup>1</sup>Department of Otorhinolaryngology, Yonsei University College of Medicine, Korea<sup>2</sup>Department of Research Center For Human Natural Defense System, Yonsei University College of Medicine, Korea

**Objectives:** ATP is known to be secreted in the marginal/supporting cells of cochlea by noise stimulation for inner ear protection. Since there are functional and morphological similarities between cochlear marginal/supporting cells and vestibular dark/supporting cells, secretion of ATP is expected in the vestibule by mechanical stress. We tried to investigate a release of ATP in the vestibule in this study.

**Methods:** Vestibular membranous labyrinth was dissected from C57BL/6 mouse. Ampulla, common crus, utricle and saccule were separated and incubated in perilymph-like solution. Gentle pipetting was applied to the fluid where each tissue and micro-glass beads were contained. The stimulation was applied for 3 times and the fluid was collected and refurnished for each procedures. The amount of ATP in collected solution was measured using a luciferin-luciferase assay kit. Quinacrine was applied to identify vesicles containing ATP in tissues.

**Results:** ATP secretion after mechanical stimulation in vestibular organ was identified. The order of concentration of ATP was ampulla (20 nm) > Utricle (13 nm) > common crus (10 nm) > saccule (7 nm). The amount of ATP returned to the baseline after 30 minutes of reincubation. This result implies that ATP is secreted by mechanical stimulation of vestibular system and main site of secretion is dark cells, because ampulla, utricle, and common crus contain dark cells whereas saccule does not. Quinacrine staining was observed in within utricle, along the dark cells lining.

**Conclusion:** ATP is likely to be secreted in the vestibular system, especially from the dark cells, by excessive acceleration stimulation to modulate neuronal signal transduction for the protection of the inner ear.

PP118

Animal Models and Molecular Approach

**ACETYLCHOLINE MUSCARINIC RECEPTOR CHANGES IN THE HIPPOCAMPUS FOLLOWING BILATERAL VESTIBULAR LOSS**Phillip AITKEN<sup>1</sup>, Alice BENOIT<sup>2</sup>, Yiwen ZHENG<sup>1</sup>, Bruno PHILOXENE<sup>2</sup>, Anne LE GALL<sup>2</sup>, Pierre DENISE<sup>2</sup>, Paul F SMITH<sup>1</sup>, Stéphane BESNARD<sup>2</sup><sup>1</sup>Department of Pharmacology And Toxicology, University of Otago, New Zealand<sup>2</sup>Department of Inserm, Université De Caen Basse-normandie, France

Bilateral vestibular loss (BVL) has been found to produce spatial memory deficits in rodents. Muscarinic cholinergic receptors, particularly the M1 and M2 receptors, have been found to be necessary in the formation and maintenance of hippocampal spatial memory. It was therefore hypothesized that there would be a decrease in the number of M1 receptors and an increase in M2 receptors following BVL. Bilateral sodium arsenite-induced vestibular lesions were performed on rats (BVL = 12; sham = 12). Either seven or thirty days following lesioning the brains were removed and prepared for autoradiography. The density of binding in the hippocampus of the selective M1 receptor ligand [3H]pirenzepine was measured. Thirty days following vestibular lesions there was a significant decrease in ligand binding ( $P \leq 0.001$ ). This did not occur at the seven day time point. It is likely that this decrease of cholinergic receptors may produce some of the memory deficits seen following BVL. A second experiment examined M2 receptors following BVL at seven and thirty days post lesion (BVL = 12; sham = 12). Flow cytometry was used to measure the number of hippocampal cells with M2 receptors and to determine whether those cells were neurons. There was a significant increase in M2 receptors on neurons ( $P \leq 0.05$ ) thirty days following BVL, however there was no significant difference between groups at seven days post-BVL. The changes in M2 receptors mirror the changes found in M1 receptors, suggesting a major long-term change in the hippocampal cholinergic system following BVL.

PP119

Autonomic Function and Vestibular Disorders

**HEMODYNAMIC RESPONSE TO AIR-CONDUCTED SOUND STIMULUS IS MEDIATED VIA VESTIBULOSYMPATHETIC REFLEX**Luka CRNOSIJA<sup>1</sup>, Antun PAVELIC<sup>1</sup>, Magdalena KRBOT SKORIC<sup>2</sup>, Ivan ADAMEC<sup>2</sup>, **Mario HABEK**<sup>1,2</sup><sup>1</sup>*Department of Neurology, University of Zagreb, School of Medicine, Croatia*<sup>2</sup>*Department of Neurology, University Hospital Center Zagreb, Croatia*

**Aims:** To investigate the existence of the vestibulosympathetic reflex in humans by comparing the hemodynamic responses to air-conducted sound stimulus of the vestibular system between healthy subjects and patients with vestibular neuritis.

**Methods:** Twenty-one healthy controls and seven patients with vestibular neuritis were included in the study. Each autonomic test was conducted first without and then with air-conducted sound stimulus of the vestibular system. The following autonomic tests were performed: heart rate response to Valsalva maneuver, heart rate response to deep breathing, heart rate and blood pressure response to supine position, passive tilt and active standing.

**Results:** In healthy participants, there was a statistically significant difference between respiratory sinus arrhythmia values without and with vestibular stimulation ( $26.63 \pm 6.16$  vs.  $24.67 \pm 7.34$  respectively,  $p = 0.02$ ). Furthermore, during the passive tilt the average heart rate value throughout air-conducted sound stimulus of the vestibular system was lower than the average heart rate values immediately preceding the air-conducted sound stimulus ( $88.63 \pm 14.68$  vs.  $90.96 \pm 14.93$ ,  $p = 0.001$ ). For the supine position and active standing there was no statistically significant difference. In patients with vestibular neuritis no such differences were observed.

**Conclusion:** This study has shown significant effect of vestibular stimulation with air-conducted sound stimulus in healthy participants on heart rate during the passive tilt, while no such difference was observed in vestibular neuritis patients. These data indicate that air-conducted sound stimulus of the vestibular system could be a valuable method for future studies of the vestibulosympathetic reflex.

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Autonomic Function and Vestibular Disorders

**CORRELATION BETWEEN ROTATION CHAIR TEST AND DIZZINESS HANDICAP INVENTORY IN PATIENTS WITH VESTIBULAR NEURITIS****Seongki AHN***Department of Otolaryngology, Gyeongsang National University, Korea*

Vestibular neuritis (VN) is one of the most common causes of acute spontaneous vertigo. However, such dizziness symptoms in patients with VN vary among patients, and various methods are used to evaluate subjective vestibular symptoms following attack of VN. Studies on correlation between subjective vestibular symptom changes and result of rotation chair test after vestibular rehabilitation therapy (VRT) have not been reported. Therefore, we compared change of DHI and results of rotation chair test in patients with VN between attack and 3 month later following VRT. Forty five patients were included in this study. The DHI score and the percentage of directional preponderance (DP) of the rotation chair test in post-VRT patients as compared to attack of VN were mostly decreased. However, no statistically significant was showed. All of the patients with VN showed asymmetry toward direction of the lesion in rotation chair test at the time of VN. Following VRT 3 month later, asymmetry still existed in 22 subjects, but 23 subjects revealed symmetry in the rotation chair test. This change showed statistically significance. No correlation between change of DP % and DHI score showed ( $r = 0.326$ ). In addition, improvement itself of the rotation chair test in patients with VN following VRT did not reflect improvement of subjective vestibular symptoms.

PP121

Benign Paroxysmal Position Vertigo

**HYBRID PROCEDURE FOR BENIGN PAROXYSMAL POSITIONAL VERTIGO IN INDIVIDUALS WITH NECK LIMITATION: CASE REPORT****Andre Luis Santos SILVA<sup>1</sup>**, Camilla CAVASSIN<sup>1</sup><sup>1</sup>*Department of Physical Therapy, Instituto Brasileiro De Fisioterapia Vestibular E Equilíbrio – Ibrafive, Brazil*

Benign Paroxysmal Positional Vertigo (BPPV) is characterized by episodic vertigo provoked by changes in head position in relationship to gravity. It is the most common vestibular disorder. The effectiveness of posterior canal BPPV treatment reported success rates for the canalith repositioning procedure (CRP) between 67% and 95%. Physical therapists specialized in vestibular rehabilitation are competent to diagnosis BPPV, to select the appropriate maneuver for each patient, and to performing the intervention. However, the CRP in individuals with poor or decreased range of motion is limited and requires a specific approach. The purpose of this case report was to determine the effect of a hybrid treatment in patients with PC-BPPV associated with cervical mobility limitation. Three patients with posterior canal BPPV and limited cervical mobility underwent hybrid procedure. Two cases of ankylosing spondylitis sequelae with left PC-BPPV and other with physical co-morbidities limiting his mobility for disuse. They were treated with hybrid procedure. This has resulted in a success rate of 93% in one visit. The patients were reviewed 2 weeks following treatment. At the follow up they were free of symptoms earlier and able to return to daily routine. The study was limited by the small amount of subjects and by not having a control group. The hybrid maneuver is feasible and safe for patients with cervical limitations, but with favorable body mobility. This technique was not associated with adverse events, which makes this promising as a treatment option for patients with PC-VPPB associated with cervical impairments.

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Benign Paroxysmal Position Vertigo

**ANALYSIS OF DIFFERENT THERAPEUTIC REGIMENS IN THE TREATMENT OF BPPV CASES****Hong LU<sup>2</sup>**, Wenli WANG<sup>1</sup>, Ou XU<sup>2</sup>, Qiaomei DAI<sup>3</sup>, Yali LUO<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Beijing Wangfu Combine Traditional Chinese And Western Medicine Hospital, China*<sup>2</sup>*Department of Ent & Hn Surgery Department, The 2nd Hospital of Hebei Medical University, China*<sup>3</sup>*Department of Otorhinolaryngology, The Shou Da Ent Hospital of Beijing, China*

A retrospective analysis was about the treatment results and history records of 116 cases patients with BPPV. According to the different treatment, the patients were divided into 3 groups, 1. 36 patients were outpatients who were treated only by canalith repositioning procedure; 2. 47 patients were treated by the combination of canalith repositioning procedure and 105 mg intravenous drip with Extract of Ginkgo biloba, at the same time, the mesylate betahistine hydrochloride, 6 mg, three times a day, was used in these patients; 3. 33 patients were treated by the SRM-IV vestibular function therapeutic system and a part of them who accepted the anti-vertigo drugs. Analysis In 116 patients with BPPV were selected, 1:1.5 ratio of men to women, average age  $51.34 \pm 14.75$  years, by single factor analysis of variance between the three groups, there was no significant difference ( $P < 0.05$ ); The three group of duration of therapy, the results were not statistically significant ( $P < 0.05$ ); There was a statistical significance ( $P > 0.05$ ) in the type of BPPV and the times of canalith repositioning procedure; There was no significant difference ( $P < 0.05$ ) by  $\chi^2$  test in the inducement and comorbidities. Conclusion BPPV patients are more prevalent in female of elderly patients, and the incidence are different in underlying diseases and inducing factors, and many factors multiple times, at the onset of seizures may have effect on the prognosis of the BPPV patients. Therapeutic effect was influence by different types. Different treatment schemes were provided for the different patients with comorbidities.



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Benign Paroxysmal Position Vertigo

**THE PERSISTENCE GEOTROPIC NYSTAGMUS OF THE BENIGN PAROXYSMAL POSITIONAL VERTIGO OF LATERAL SEMICIRCULAR CANAL**Wang LIYI<sup>1</sup>, Peng HAO<sup>1</sup>, Huang WEINING<sup>1</sup><sup>1</sup>Department of Ent, Beijing Hospital, China

**Objectives:** This is a retrospective case series to analysis the characteristics of different types of HSC-BPPV and to evaluate the efficacy of barbecue roll maneuver (BRM).

**Methods:** Using video-oculography, nystagmus during head-roll test and Dix-Hallpike test was evaluated in 1772 patients with symptoms of positional vertigo. 244 patients with horizontal nystagmus were included. BRM was the treatment to these patients. Efficacies immediately after the repositioning maneuver were evaluated.

**Results:** The total efficacy of the HSC-BPPV by BRM is 57.8%. 185 patients were geotropic nystagmus and 59 patients were apogeotropic DCPN. Among the geotropic nystagmus cases: 141 patients were transient geotropic nystagmus with an efficacy of 83.7% (118/141) after BRM while 44 patients were persistence geotropic nystagmus with an efficacy of 0% (0/44) after BRM. As for the apogeotropic nystagmus cases the total efficacy is 39.0% (23/59). Also we found that, the nystagmus of 7 apogeotropic DCPN cases changed to geotropic nystagmus during BRM therapy, and the efficacy of them is 100% (7/7). The efficacy of the other cases with apogeotropic nystagmus is 30.7% (16/52).

**Conclusion:** BRM is an effective treatment to HSC-BPPV with transient geotropic nystagmus and apogeotropic nystagmus. However, BRM is not a proper therapy for persistence geotropic nystagmus.

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Benign Paroxysmal Position Vertigo

**CLINICAL RESEARCH OF OTOLITH ABNORMAL MIGRATION DURING CANALITH REPOSITIONING PROCEDURES FOR BPPV PATIENTS**Zhiling CHEN

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**Abstract:** Objective To investigate the clinical characteristics of otolith abnormal migration following canalith repositioning procedures (CRPs) for benign paroxysmal positional vertigo (BPPV) patients. The diagnosis, treatment and prevention approaches are also discussed. Methods Totally 356 cases of unilateral BPPV patients were treated by CRPs between January, 2010 and December, 2015. Otolith abnormal migration following CRPs were recorded and analyzed with type and risk factors.

**Results:** The incidence rate of otolith abnormal migration in 356 cases was totally 4.78% (17/356), with canal conversion in 2.8% (10/356), cupulolithiasis and canalolithiasis conversion in 0.84% (3/356), and primarily canal reentry in 1.12% (4/356). The risk factors were Dix – Hallpike test immediately performed after CRPs ( $\chi^2 = 27.512$ ,  $P < 0.05$ ) and another CRPs after treatment ( $\chi^2 = 26.386$   $P < 0.05$ ). Sex, age, course, involved semicircular canals and whether CRPs in accordance with the standard was not significant ( $P > 0.05$ ). Conclusion Otolith abnormal migration is a complication following CRPs for BPPV. Diagnosis is based on careful assessment of the symptom and the pattern of nystagmus observed after CRPs. To prevent the occurrence of otolith abnormal migration, another Dix – Hallpike test or CRPs immediately performed after treatment is not recommended.

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Benign Paroxysmal Position Vertigo

**DIAL “V” FOR VERTIGO: APPLICATION OF THE “A-VOR” APP IN BPPV TEACHING COURSES**Julia DLUGAICZYK<sup>1</sup>, Michael THIEMER<sup>1</sup>, Christian NEUBERT<sup>1</sup>, Bianca SCHORN<sup>1</sup>, Bernhard SCHICK<sup>1</sup><sup>1</sup>Department of Otorhinolaryngology, Saarland University Medical Center, Homburg/Saar, Germany, Germany

**Objective:** BPPV is the most common disorder of the vestibular organ. However, this easy-to-cure cause of vertigo is still often misdiagnosed and left untreated in everyday clinical practice. Therefore, the present study aimed to inves-

tigate whether the use of an app-based training tool (aVOR app: <https://itunes.apple.com/de/app/avor/id497245573?mt=8>) in teaching courses for medical students improves their ability to perform the Epley repositioning maneuver for BPPV correctly.

**Methods:** Students were randomly assigned to two variants of a BPPV teaching course (without aVOR app:  $n = 67$ ; with aVOR app:  $n = 46$ ). Students' satisfaction was assessed with a standardized questionnaire for the evaluation of student courses at Saarland University Medical School. Furthermore, the students' ability to perform the steps of the Epley maneuver in the correct order was tested at the end of the term.

**Results:** Application of the aVOR app increased students' satisfaction with the course in the following aspects: quality of teaching media, learning success, overall satisfaction, recommendation to other students (t-test:  $p \leq 0.05$ , respectively). While 56% of students in the aVOR group were able to apply the steps of the Epley maneuver in the correct order, only 26% of the students in the group without the aVOR app succeeded in this task at the end of the term (Fisher's exact test:  $p = 0.004$ ).

**Conclusion:** The aVOR app is a useful hands-on training tool for teaching the treatment of BPPV to medical students.

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Benign Paroxysmal Position Vertigo

#### **DIFFERENTIAL DIAGNOSIS OF GEOTROPIC POSITIONAL NYSTAGMUS IN PATIENTS WITH BPPV**

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Patients with the horizontal canal type of benign paroxysmal vertigo (H-BPPV) show geotropic (GH-BPPV) or apogeotropic positional nystagmus. There are two types of geotropic positional nystagmus, one is transient (TGPN) and the other is persistent (PGPN). In ENT office, differentiation between TGPN and PGPN is determined in patients with GH-BPPV, based on whether their nystagmus gradually declined or not by means of an infrared CCD camera or Frenzel glasses. In the present study, we analyzed positional nystagmus three-dimensionally in 47 patients with GH-BPPV and diagnosed TGPN and PGPN with time constant (TC) of slow phase of eye velocity of positional nystagmus. TGPN with TC of  $> 35$  sec was diagnosed in 36 patients and PGPN with TC of  $< 35$  sec was diagnosed in 11 patients. Ten independent otolaryngologists then distinguished TGPN from PGPN after 10 sec- or 30 sec-observation of positional nystagmus image recording of an infrared CCD camera. The sensitivity and specificity for discrimination of TGPN after 30 sec-observation of positional nystagmus was 100% and 97%, respectively. These findings suggested that 30 sec-observation of positional nystagmus image recording with an infrared CCD camera is sufficient to distinguish TGPN from PGPN of patients with H-BPPV in ENT office.

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Benign Paroxysmal Position Vertigo

#### **A CASE WITH VARIOUS NYSTAGMUS INVERSIONS IN THE HORIZONTAL CANAL VARIANT OF BENIGN PAROXYSMAL VERTIGO.**

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**Introduction:** The horizontal canal variant of benign paroxysmal vertigo (HC-BPPV) is characterized by a bi-directional-changing positional nystagmus with a positional change. Canalolithiasis and Cupulolithiasis may both play a role in HC-BPPV. Some patients with HC BPPV present with spontaneous inversion of nystagmus without a positional change. We encountered a case with various nystagmus inversions of positional test during follow up and we speculate on the possible mechanism of nystagmus inversion.

The case was 63-year-female. The patient had the positional changing geotropic nystagmus on the both sides, showing spontaneous inversion of direction in both sides. The patient was diagnosed as having HC-BPPV. At the second visit, the patient showed the positional changing ageotropic nystagmus. We tried the head-shaking as a treatment, after that the patient showed geotropic nystagmus. At the third visit, the nystagmus was disappeared.

**Conclusion:** The coexistence of cupulolithiasis and canolithiasis appeared to be a possible mechanism of nystagmus inversion.

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Benign Paroxysmal Position Vertigo

### NATURAL HISTORY OF HORIZONTAL CANAL BENIGN PAROXYSMAL POSITIONAL VERTIGO IS TRULY SHORT

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The objective of the study is to characterize the natural course of positional vertigo and nystagmus in patients with horizontal canal benign paroxysmal positional vertigo (h-BPPV) and to analyze the difference in the natural course between the two variants of h-BPPV. We conducted a prospective study in 106 patients with geotropic type h-BPPV [h-BPPV (Geo)] ( $n = 43$ ) and apogeotropic type h-BPPV [h-BPPV (Apo)] ( $n = 63$ ) who agreed and signed the written informed consent of no treatment. All patients were asked to answer a detailed interview about the onset time of positional vertigo and to visit the hospital every 1–3 days. At every visit, they were interviewed about cessation time of positional vertigo and positional nystagmus was assessed. The mean period  $\pm$  SD between the onset and remission of vertigo in the h-BPPV (Geo) was  $6.7 \pm 6.3$  days, whereas that in the h-BPPV (Apo) was  $3.7 \pm 4.1$  days. In addition, the mean period  $\pm$  SD from the initial diagnosis to the disappearance of positional nystagmus in the h-BPPV (Geo) was  $4.7 \pm 3.9$  days, whereas that in the h-BPPV (Apo) was  $4.4 \pm 5.0$  days. Although the duration until natural remission of positional nystagmus did not differ between the two variants of h-BPPV, the remission of vertigo occurred faster in h-BPPV (Apo) than h-BPPV (Geo) ( $p < 0.05$ ). The positional vertigo disappeared faster in the h-BPPV (Apo) compared to the h-BPPV (Geo) unlike the positional nystagmus.

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Benign Paroxysmal Position Vertigo

### THERAPEUTIC EFFICACY OF A MODIFIED EPLEY'S MANEUVER UNDER THE 'SHOULDER ON THE PILLOW' POSITION

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**Purpose:** The authors designed a modified Dix-Hallpike test and subsequent modified Epley's maneuver under 'shoulder on the pillow' position, which places a pillow under the patient's shoulders so that when the neck extends, the head touches the bed floor. The aim of this study is to evaluate the usefulness of our modification of canalith repositioning maneuver(CRM) for posterior canal benign paroxysmal positional vertigo.

**Method:** This study was multi-institutional, prospective, randomized, single-blind, and controlled clinical study. Using a random table, the patient was assigned to group A and group B. Group A patients were performed a modified

Epley's maneuver under the classical head-hanging position, and group B patients were performed a modified Epley's maneuver under the 'shoulder on the pillow' position. The presence of nystagmus and vertigo on positional testing were evaluated at a week after one session of CRM.

**Result:** Three university hospitals participated in this study, and the total number of patients included in this study was 41 patients. Out of 41 patients, 21 patients assigned to group A and 20 patients assigned to group B. Resolution rates at 1 week after treatment were 85.7% in group A and 85% in group B.

**Conclusion:** The therapeutic efficacy of a modified Epley's maneuver under the 'shoulder on the pillow' position was equivalent to a modified Epley's maneuver under classical head-hanging position. Thus, this modification may be an alternative when the patient cannot take a head-hanging position.

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Benign Paroxysmal Position Vertigo

### THE VIDEO HEAD IMPULSE TEST IN POSTERIOR CANAL BENIGN PAROXYSMAL POSITIONAL VERTIGO (P-BPPV)

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**Objectives:** To investigate the clinical characteristics and the results of video head impulse test (vHIT) of p-BPPV.

**Materials and Methods:** We retrospectively analyzed 169 patients with idiopathic p-BPPV. All patients were tested with video-nystagmography that included the Dix-Hallpike test. In addition, we evaluated the results of vHIT in the posterior canal plane before and after canalith repositioning maneuver (CRM). We divided p-BPPV patients into two groups, which could be achieved successful treatment in initial (s-CRM) or not (n-CRM). Finally, we further analyzed patients with positive vHIT.

**Results:** Of the 169 p-BPPV patients, 11 (6.5%) showed positive ipsilesional vHIT in posterior canal plane. Average age of positive vHIT group was significantly older than negative vHIT group. ( $p = 0.00$ ) While 82.9% of patients with negative vHIT were successfully treated in the initial visit day, 63.6% of patients with positive vHIT could be achieved successful repositioning, but there was no statistical significance. ( $p = 0.11$ ) Duration of positioning nystagmus in s-CRM group was significantly longer than n-CRM group. ( $p = 0.013$ ) Of 11 patients of positive vHIT, 4 patients showed negative conversion. But 4 patients showed positive vHIT even at follow up period regardless of successful repositioning.

**Conclusions:** In about 6.5% of p-BPPV patients, the deficit of VOR for ipsilesional posterior canal could be concurrent. But, positive vHIT did not showed firm correlation with treatment outcome. In addition, positive vHIT results in some patients could be normalized after reposition within right after reposition or few days. Therefore, different mechanism in generation of positive vHIT might exist, such as otolith movement.

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Benign Paroxysmal Position Vertigo

### DISCREPANCY BETWEEN THE RESULTS OF CANAL FUNCTION TESTS IN PATIENTS WITH BENIGN PAROXYSMAL POSITIONING VERTIGO

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**Background and purpose:** Caloric irrigation is a non-physiological and time-consuming examination which tests horizontal vestibular ocular reflex (hVOR) in the low-frequency range of up to 0.003 Hz. In contrast, video-head impulse test (vHIT) is easy to perform and examines the hVOR in its physiological working range of 4–7 Hz. Compared with the caloric test, vHIT have shown high specificity (90–100%) but low sensitivity (34–56%) in different peripheral vestibular diseases. Canal paresis in patients with benign paroxysmal positioning vertigo (BPPV) has been variously reported to be present in 26 to 50%. The aim of this study was to compare the results of caloric testing and vHIT in patients with BPPV.

**Method:** Patients with BPPV (n=26) were tested by vHIT and caloric testing. We compared VOR gain and catch-up saccades of vHIT with the canal paresis of caloric testing.

**Results:** The caloric test was abnormal in 38% of patients with BPPV, while the vHIT showed an abnormal VOR gain in only 10.4% of BPPV patients ( $p < 0.05$ ). However, vHIT revealed catch-up saccades in 25% of BPPV patients, and therefore, 43% of BPPV patients showed VOR deficits. In all, 60% of patients with an abnormal caloric test had a normal vHIT, whereas 71% of those with an abnormal vHIT had a normal caloric test.

**Conclusion:** This study shows a significant discrepancy between the results of caloric testing and vHIT in the patients with BPPV. To improve the diagnostic value of vHIT in BPPV, further evaluation about the significance of gain asymmetry and objective criteria for the detection of catch-up saccades are also needed.

PP132

Benign Paroxysmal Position Vertigo

### **IDENTIFICATION OF BENIGN PAROXYSMAL POSITIONAL VERTIGO MUST BE INCLUDED IN FALLS SERVICES**

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**Introduction:** BPPV is a significant risk factor for falls but under diagnosed. This falls prevention service aimed to identify and modify risk factors for falls in a large community dwelling population (145,000 total primary care list size) using an integrated care model.

**Methods:** Audit of GP computerized records followed by postal questionnaire identified all persons over 60 with recognized risk factors for falls. This group underwent a comprehensive community based assessment including: Physiotherapy assessment. Nurse review: ECG, Lying and standing BP, MMSE, GDS, FES, visual acuity Medical assessment- targeted history and examination for dizziness, vertigo, falls and syncope, FRAX score/bone health. Recommendations given to GP on new diagnoses made.

**Results:** 4038 patients assessed in 4 years. 174 new diagnoses of posterior canal BPPV 4.3% prevalence. Mean age 73.8. Range 60–91 62% females. 52% had fallen 54% had right, 38% left and 8 % bilateral BPPV. 1 Horizontal. Duration of symptoms 2 months to 10 years.

Additional intervention was 27% of these patients referred to balance class, 17% referred for DEXA on basis of FRAX tool, 7% had orthostatic hypotension, 5% bradycardia requiring review, also new atrial fibrillation, depression, cognitive impairment identified.

**Conclusion:** Active identification and treatment of BPPV must be part of falls prevention services. Any service seeing older persons with BPPV should consider additional modifiable risk factors for falls including gait disorders, osteoporosis, cardiovascular diagnoses with the aim of reducing falls.

PP133

Benign Paroxysmal Position Vertigo

### **NYLEN-BARANY POSITIONING TEST**

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The Nylen-Barany positioning testing is a useful addition to standard Dix-Hallpike positioning testing. The history and technique of the Nylen-Barany positioning test is reviewed, and the clinical utility of the test in diagnostic vestibular assessment is illustrated with case studies of patients who repeatedly do not show nystagmus with Dix-Hallpike positioning but demonstrate vigorous torsional nystagmus consistent with posterior semicircular canal BPPV when Nylen-Barany positioning is performed. Horizontal nystagmus may also be elicited by the Nylen-Barany positioning test, suggesting lateral semicircular canal BPPV.

PP134

Bilateral Vestibulopathy

**A CASE OF NONENCEPHALOPATHIC VESTIBULAR WERNICKE SYNDROME**Jong-Min LEE<sup>1</sup>, Jae-Chan RYU<sup>1</sup>, Sun-Young KIM<sup>1</sup>, Jee-Hyun KWON<sup>1</sup>, Ji-Yun PARK<sup>1</sup><sup>1</sup>Department of Neurology, Ulsan University Hospital, Ulsan University College of Medicine, Ulsan, Korea

Wernicke's encephalopathy is an acute, neuropsychiatric syndrome that results from a deficiency vitamin B1 (thiamine). Its essential features are ophthalmoplegia and/or nystagmus, mental status changes, and unsteadiness of stance and gait. Non-encephalopathic presentations of CNS thiamine deficiency may be difficult to diagnosis. We describe vestibular signs during the early phase of suspected Wernicke encephalopathy without encephalic symptoms.

A 64-year-old male presented oscillopsia and disequilibrium for 3 days. He had a history of chronic alcoholics without vascular risk factors. Neurologic examination showed horizontal gaze-evoked nystagmus (GEN), spontaneous UBN, bilateral HIT signs and trunkal ataxia without limbs ataxia. He had normal orientation and sensorium, had a normal Mini-Mental State Examination score (30/30). He showed no response to bithermal caloric irrigation of each ear and bilaterally abnormal horizontal head impulse tests. Rotatory chair test showed low gain, phase lead and no asymmetry, Brain MRI shows diffuse cerebellar and cerebral atrophy without acute focal CNS structural lesion. We began thiamine replacement following clinical examination. He improved dramatically after IV thiamine.

Thiamine deficiency should be considered acute bilateral combined vestibulopathy (bilateral vestibular failure plus GEN with/without vertical nystagmus) even absent encephalic symptom. Supplement of high dose IV thiamine is essential for both therapeutic and diagnostic approach.

PP135

Bilateral Vestibulopathy

**BILATERAL VESTIBULAR HYPOFUNCTION: INSIGHTS IN ETIOLOGIES, CLINICAL SUBTYPES AND DIAGNOSTICS**R. VAN DE BERG<sup>1,4</sup>, F. LUCIEER<sup>1</sup>, P. VONK<sup>2</sup>, N. GUINAND<sup>3</sup>, R. STOKROOS<sup>1</sup>, H. KINGMA<sup>1,4</sup><sup>1</sup>Department of Otorhinolaryngology And Head And Neck Surgery, Division of Balance Disorders, Faculty of Health Medicine And Life Sciences, School For Mental Health And Neuroscience, Maastricht University Medical Center, Maastricht, Netherlands<sup>2</sup>Department of Health, Medicine And Life Sciences, Maastricht University, Maastricht, Netherlands<sup>3</sup>Department of Clinical Neurosciences, Service of Otorhinolaryngology And Head And Neck Surgery, Geneva University Hospitals, Geneva, Switzerland<sup>4</sup>Department of Physics, Tomsk State Research University, Russia

**Introduction:** Bilateral vestibular hypofunction (BVH) is a heterogeneous condition for which no definite diagnostic criteria have been established yet. In order to develop specific criteria, more insight is needed in etiologies, clinical subtypes and the value of diagnostic tools.

**Objective:** To evaluate the different etiologies and clinical subtypes of BVH and the value of diagnostic tools in the diagnostic process of BVH. Materials and methods: A retrospective case review was performed on 154 patients diagnosed with BVH, between 2013 and 2015. Inclusion criteria: 1) imbalance and/or oscillopsia during locomotion, and 2) summated slow phase velocity of nystagmus of less than 20 degrees per second during bithermal caloric tests.

**Results:** BVH resulted from more than 20 different etiologies. In the idiopathic group, the percentage of migraine was significantly higher compared to the non-idiopathic group (50% versus 11%,  $p < 0.001$ ). All 4 clinical subtypes were found. Slowly progressive BVH with ataxia comprised only 4.5% of the cases. The head impulse test was abnormal in 94%, the torsion swing test was abnormal in 66%, bilateral normal hearing to moderate hearing loss was found in 49% and cerebral imaging was abnormal in 14% of the population.

**Conclusion:** BVH has various etiologies and clinical characteristics. Migraine seems to play a significant role in idiopathic BVH. The torsion swing test is not the "gold standard" for diagnosing BVH due to its lack of sensitivity. Future diagnostic criteria of BVH should consist of standardized vestibular tests combined with a history that is congruent with the vestibular findings.

PP136

Central Vestibular Disorders

**NON PHOSPHORYLATED NEUROFILAMENT LABELLING IN HUMAN DEITERS' VESTIBULAR NUCLEUS NEURONS IN PARKINSON'S DISEASE****Thomas P WELLINGS**<sup>1,2,3</sup>, Alan M BRICHTA<sup>1,2</sup>, Rebecca LIM<sup>1,2</sup><sup>1</sup>*Department of Biomedical Sciences And Pharmacy, The University of Newcastle, Australia*<sup>2</sup>*Department of Brain And Mental Health, Hunter Medical Research Institute, Australia*<sup>3</sup>*Department of Neurology, John Hunter Hospital, Australia*

**Background:** A characteristic feature of lateral vestibular nucleus (LVN) is the presence of large multipolar neurons called Deiters' neurons. Their descending axons project ipsilaterally in the spinal cord as the lateral vestibulospinal tract. Deiters' neurons also express the cytostructural protein, non-phosphorylated neurofilament protein (NPNFP). NPNFP is expressed in other populations, including motoneurons and dopaminergic neurons of the substantia nigra. Studies show decreased striatal NPNFP-immunoreactivity in patients with Parkinson's disease (PD), but not in progressive supranuclear palsy (PSP). Although both these disorders exhibit impaired postural reflexes, we hypothesised that NPNFP-expression is altered in Deiters' neurons in patients with PD and postural instability.

**Methods:** All procedures were approved by The University of Newcastle Human Ethics Committee. Tissue from 6 controls, 6 PD donors with postural instability, and 2 PSP donors, was provided by the Sydney Brain Bank, Australia. For each donor, 5 brainstem sections (50  $\mu\text{m}$ ) containing the LVN were labelled. NPNFP-immunopositive neurons with an area of  $> 2000 \mu\text{m}^2$  (diameter  $> 50 \mu\text{m}$ ) and within the boundaries of the LVN were counted as Deiters' neurons.

**Results:** In controls, there were  $25.6 \pm 3.0$  NPNFP immunopositive Deiters' neurons/section. In PD donors there was a 50% decrease in the number of NPNFP immunopositive neurons with only  $13.0 \pm 2.0$  neurons/section ( $p < 0.01$ ). In contrast, there were no differences in neuronal counts between PSP ( $n = 22.8 \pm 3.0$  neurons/section) and controls.

**Conclusion:** The decline in expression of NPNFP in patients with PD corresponds to a deterioration in descending reflexive postural control. This finding supports the notion for a pathophysiological explanation of postural instability in Parkinson's disease.

PP137

Central Vestibular Disorders

**EVALUATION OF EYE MOVEMENTS AND VESTIBULAR FUNCTION IN POSTERIOR CIRCULATION STROKE PATIENTS**Sang WENWEN<sup>1</sup>, Wang WEIYING<sup>2</sup>, Xu ZHIWEI<sup>3</sup>, Hong YUAN<sup>4</sup>, Yan SHUANGMEI<sup>5</sup>, **Yang XU**<sup>6</sup><sup>1</sup>*Department of Neurology, The Graduate Student Training Base-aerospace Center Hospital of Liaoning Medical University, China*<sup>2</sup>*Department of Neurology, The Graduate Student Training Base-aerospace Center Hospital of Liaoning Medical University, China*<sup>3</sup>*Department of Neurology, The Graduate Student Training Base-aerospace Center Hospital of Liaoning Medical University, China*<sup>4</sup>*Department of Neurology, The Graduate Student Training Base-aerospace Center Hospital of Liaoning Medical University, China*<sup>5</sup>*Department of Neurology, Peking University Health Science Center, China*<sup>6</sup>*Department of Neurology, Aerospace Center Hospita, China*

**Objective:** The aim of this study was to determine the importance of eye movements and vestibular function in diagnosing Posterior circulation stroke. **Methods:** A total of 37 posterior circulation stroke patients with confirmed PCS diagnosis and neuroimaging results were included in this study. Clinical information of the involved patients was collected including gender, age, onset symptom, risk factors and admission signs. All patients underwent a series of tests using videonystagmography for noninvasive evaluation of the eye movements and vestibular function.

**Results:** 29 (78.4%) patients showed at least one abnormality in eye movement including 4 by gazes test, 11 by saccade test, 15 by smooth pursuit test and 12 by optokinetic nystagmu test. In terms of the vestibular function,

spontaneous nystagmus was observed in 13 (35.1%) patients. head shaking nystagmus was observed in 14 (45.1%) patients. Impaired fixation suppression was observed in 9 (27.2%) patients. Relating the assessment of eye movements and vestibular function to the neuron imaging revealed that Cerebellar infarction in the territory of Posterior Inferior Cerebellar Artery was most frequent in patients with isolated vertigo. In addition, the horizontal component of the spontaneous nystagmus and the head shaking nystagmus always beat toward the lesion side. Fixation suppression test was usually successful. Downbeat nystagmus can be induced in patients with of pontine infarcts. In those patients, fixation suppression test was usually failed.

**Conclusion:** Abnormalities in eye movements is common in PCS patients presented with dizziness/vertigo and can be used to screen the patients.

PP138

Central Vestibular Disorders

**MODULATION OF CENTRAL NYSTAGMUS BY VISION, PROPRIOCEPTION, AND EFFERENCE COPY SIGNALS: A SYSTEMATIC EVALUATION**

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Non-vestibular sensorimotor signals modulate the vestibular nucleus neuron to achieve current behavioral goals, and may generate or modulate nystagmus. In central lesions affecting the vestibular nuclei, non-vestibular signals such as mastication or swallowing may induce nystagmus. However, the influence of non-vestibular signals on these types of nystagmus has not been investigated in a systematic way and the underlying mechanisms of the modulation are poorly understood. In this study, several non-vestibular sensorimotor stimuli were applied to evaluate the patterns of nystagmus modulation in a patient with suspected rhombencephalitis or imaging negative small infarction, probably involving the left dorsolateral medulla. The nystagmus was induced or significantly modulated by i) visual inputs, and ii) combined proprioceptive and efference copy signals (during voluntary motion) unrelated to body or head orientation. In contrast, isolated proprioceptive signal, mental set, or non-proprioceptive somatosensory inputs showed a negligible effect on the induction of nystagmus. Based on these modulations, we suggest that i) the visually-mediated nystagmus is due to a lesion-induced pursuit asymmetry, and ii) the nystagmus induced during voluntary motion is due to erroneous contribution of combined proprioceptive and efference copy signals during integration of non-vestibular signals for ocular motor control. Various non-vestibular sensorimotor stimulations may induce nystagmus due to dysfunction of the central vestibular neural circuitry.

PP139

Central Vestibular Disorders

**DOWNBEAT NYSTAGMUS ASSOCIATED WITH BILATERAL PARAMEDIAN TRACT NEURONS LESION IN PONS**

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**Introduction:** Downbeat nystagmus is characterized by slow upward drifts and fast downward phases. Downbeat nystagmus may be caused by lesions of the vestibulocerebellum, toxic adverse effects of medication (for example, phenytoin, carbamazepine, lithium, morphine derivatives) and brainstem stroke. So far, there have been only a few reports about paramedian pontine tegmentum lesion associated with downbeat nystagmus. I report a case with downbeat nystagmus associated with bilateral paramedian tract neurons lesion in pons.

**Case:** A 73-year-old-woman presented with dizziness for 5 days. Four years previously, she had suffered a infarction in pontine tegmentum with bilateral internuclear ophthalmoplegia. On admission, she had downbeat nystagmus using Frenzel goggles with full range of motion of both eyes. Downbeat nystagmus was observed in the primary eye position and was increased in lateral gaze, especially to the right. Her brain magnetic resonance imaging revealed an old infarction in pontine tegmentum including bilateral medial longitudinal fasciculus with small vessel disease.

**Conclusion:** This case report suggests that paramedian tract neurons may play an important role in the vertical vestibular balance control.



PP140

Central Vestibular Disorders

**ABNORMAL EYE MOVEMENTS IN NUCLEUS PREPOSITUS HYPOGLOSSI LESIONS**Sung-Hee KIM<sup>1,4</sup>, Hyo Jung KIM<sup>2</sup>, David ZEE<sup>3</sup>, Ji-Soo KIM<sup>1</sup><sup>1</sup>*Department of Neurology, Seoul National University Bundang Hospital, Korea*<sup>2</sup>*Department of Biomedical Laboratory Science, Kyungdong University, Korea*<sup>3</sup>*Department of Neurology, Ophthalmology, Otolaryngology – Head And Neck Surgery, The Johns Hopkins University School of Medicine, USA*<sup>4</sup>*Department of Neurology, Kyungpook National University Hospital, Korea*

The nucleus prepositus hypoglossi (NPH) is a key constituent of a vestibular-cerebellar-brainstem neural network that ensures the eyes hold steady in desired positions of gaze. Nine patients with a lesion involving the NPH showed ipsilesionally beating spontaneous nystagmus, horizontal gaze-evoked nystagmus more intense on looking toward the lesion side, impaired smooth pursuit more to the lesion side, central patterns of head shaking nystagmus, static ocular contrapulsion, and decreased gain of the vestibulo-ocular reflex during contralesionally-directed head impulses. These ocular motor findings may be ascribed to an imbalance in the NPH-inferior olive-flocculus-vestibular nucleus loops on both sides of the brainstem. A unilateral NPH lesion may present acute vestibular syndrome with a unique pattern of ocular motor abnormalities.

PP141

Central Vestibular Disorders

**VOR DYNAMICS DURING PASSIVE HEAD-IMPULSES: SLOW PHASE AND QUICK-EYE MOVEMENTS IN HUNTINGTON'S DISEASE**Leonel LUIS<sup>1,2</sup>, João COSTA<sup>2,3</sup>, Esteban MUNOZ<sup>3</sup>, Erich SCHNEIDER<sup>4</sup>, Josep VALLS-SOLÉ<sup>3</sup><sup>1</sup>*Department of Clinical Physiology Translational Unit, Imm, Faculty of Medicine, University of Lisbon, Portugal*<sup>2</sup>*Department of Otolaryngology, Hospital De Cascais, Portugal*<sup>3</sup>*Department of Neurology, Emg And Motor Control Unit, Hospital Clínic, Universitat De Barcelona, Spain*<sup>4</sup>*Department of Institute of Medical Technology, Brandenburg University of Technology, Germany*

Angular vestibular ocular reflex (VOR) can be assessed with the video head-impulse test (vHIT), allowing the quantification of VOR) at a physiological frequency domain, as well as the characterization of quick eye movements (QEM) triggered with head impulses.

We explored 18 genetically confirmed HD patients ( $44.7 \pm 8.1$  years; male = 9), classified as Shoulson and Fahn severity stages 1 ( $n = 5$ ; pre-symptomatic), 2 ( $n = 4$ ), 3 ( $n = 8$ ) and 4 ( $n = 1$ ) based on their Total Functional Capacity (TFC) scores, and 40 healthy controls ( $39.9 \pm 16.5$  years; male = 20). We calculated the VOR latency and gain and determined the latency, peak-velocity and occurrence rate of the QEM triggered during and after head impulses.

VOR latency and gain were not different from controls ( $p > 0.29$  for both comparisons). No differences were found between presymptomatic and symptomatic patients. QEM were present in 11 patients and 18 controls, always after the head impulse and compensatory. QEM latency ( $174.5 \pm 41.2$  ms), peak velocity ( $71.58 \pm 34.48^\circ/\text{s}$ ) and occurrence rate ( $0.45 \pm 0.29$ ) were not different from controls ( $p > 0.11$  for all comparisons). Though not realizing it, 5 of the symptomatic patients majorly failed to direct gaze in darkness, both horizontal as vertically, this correlating with TFC scores (Spearman  $r = 0.65$ ,  $p = 0.005$ ).

VOR seems to be preserved at physiological frequency domains in HD patients, even in more advanced stages of the disease. Although both voluntary saccades and quick phases of nystagmus are known to be slower in HD, quick eye movements triggered with impulses showed no differences in comparison to controls. Gaze failure in darkness may prove beneficial as a biological marker for HD.

PP142

Central Vestibular Disorders

**THE INCIDENCE OF ABNORMAL SUBJECTIVE VISUAL VERTICAL IN MULTIPLE SCLEROSIS DURING ROD AND ROD-AND-FRAME CONDITIONS****Brooke N KLATT**<sup>1</sup>, Patrick J SPARTO<sup>1</sup>, Lauren TERHORST<sup>2</sup>, Stanley WINSER<sup>3</sup>, Rock HEYMAN<sup>4</sup>, Islam ZAYDAN<sup>4</sup>, Susan L WHITNEY<sup>1</sup><sup>1</sup>*Department of Physical Therapy, University of Pittsburgh, USA*<sup>2</sup>*Department of Occupational Therapy, University of Pittsburgh, USA*<sup>3</sup>*Department of Physiotherapy, University of Otago, New Zealand*<sup>4</sup>*Department of Neurology, University of Pittsburgh, USA*

**Purpose:** Disruption of the vestibular system resulting from the pathophysiology of multiple sclerosis (MS) is not uncommon. Subjective Visual Vertical (SVV) deviations (rod condition) are correlated to abnormal cerebellar function in individuals diagnosed with MS but SVV during static visual disturbances (rod-and-frame condition) have not been investigated. Additionally, the relationship between SVV abnormalities and functional outcome measurements have not been explored within this population.

**Method:** Twenty participants (15 females), mean age 54.5 years old ( $\pm 7.03$  SD), who were diagnosed with MS by a neurologist and had signs of cerebellar involvement (gait ataxia, limb ataxia, dysarthria, and/or nystagmus) completed the Barthel Index questionnaire, Berg Balance Scale (BBS), gait velocity, and computerized SVV testing. SVV testing included 4 trials of the rod only condition, 4 trials of the rod-and-frame condition with the frame rotated clockwise (CW), and 4 rod-and-frame condition trials with the frame rotated counter clockwise (CCW).

**Outcomes:** Only four participants yielded results within normal limits for all three SVV testing conditions. Each of these four participants scored 100 on the Barthel Index (40% of the sample scored 100/100), BBS scores  $\geq 52/56$  (45% of the sample scored  $\geq 52/56$ ), and gait velocities  $\geq 1.0$  m/sec (45% of the sample had gait velocities  $\geq 1.0$  m/sec).

**Conclusion:** In this sample, 80% of the individuals displayed SVV abnormalities. Implementation of SVV assessment for individuals with MS may provide valuable information to identify the best interventions and with future research, may potentially have predictive power in determining functional impairment and fall risk.

PP143

Central Vestibular Disorders

**A RADIOGRAPHIC TARGET SIGN FOR ABNORMAL VERTEBRAL ARTERY FLOW IN STROKE PATIENTS WITH ACUTE VESTIBULAR SYNDROME****Jorge C KATTAH**<sup>1</sup>, Ali S SABER THERANI<sup>1</sup>, Jeffrey DE SANTO<sup>1</sup>, John H PULA<sup>1</sup>, David E NEWMAN TOKER<sup>2</sup><sup>1</sup>*Department of Neurology, University of Illinois College of Medicine. Peoria. Illinois Neurologic Institute, USA*<sup>2</sup>*Department of Neurology, Johns Hopkins University, USA*

**Objective:** To identify vertebral artery (VA) flow abnormality seen as V4 segment hyper-intensity on axial T2MRI in patients with acute vestibular syndrome (AVS), and investigate association with stroke.

**Methods:** Retrospective study of 223 AVS patients; 140 had available T2MRI scan (153 scans). MRIs were reviewed blindly by a neuro-radiologist and a clinician for presence of V4 segment hyper-intensity or asymmetry (target sign). We report target sign presence, odds ratio, target sign and lesion laterality, target sign in negative initial DWI MRI, and Kappa for inter-rater reliability.

**Results:** Of the 140 AVS patients, 68 had stroke, 72 vestibular neuritis (VN). VAV4 segment hyper-intensity was seen in 45.6% of strokes (37/68), and 5.6% of patients with VN (4/72). Odds of stroke in patients with a "target sign" was 20.3 (95%CI 6.6–61.9). Except in one stroke patient, all found target signs were ipsilateral to stroke side. Among stroke patients with negative initial DWI MRI, 50% (6/12) had a VAV4 segment hyper-intensity. Cohen's kappa was 0.78.

**Conclusion:** The VAV4 segment hyper-intensity or "target sign" identified pathologic VA abnormalities in a nearly half of stroke patients presenting with AVS. When the vertebral artery is involved in the pathogenesis of the stroke, search for a target sign may detect an abnormality that precedes changes in DWI MRI

PP144

Clinical Testing for Vestibular Function

**IMPACT OF COCHLEAR IMPLANT IN PERIPHERAL VESTIBULAR FUNCTION****Claudio Rene MARQUEZ**<sup>1,2,3,4,5</sup>, Sergio CARMONA<sup>1,2,3,4,5</sup>, Romina Amalia WEINSCHLBAUM<sup>1,2,3,4,5</sup>, Vicente Guillermo DIAMANTE<sup>1</sup>, Joaquin REYES MIRANDA<sup>1</sup><sup>1</sup>*Department of Otoneurology, Instituto Superior De Otorrinolaringologia., Argentina*<sup>2</sup>*Department of Neurotology, Instituto Superior De Otorrinolaringologia, Argentina*<sup>3</sup>*Department of Otoneurology, Instituto Superior De Otorrinolaringologia. Instituto De Nuerociencias De Buenos Aires, Argentina*<sup>4</sup>*Department of Otolology, Instituto Superior De Otorrinolaringologia, Argentina*<sup>5</sup>*Department of Otoneurology, Instituto Superior De Otorrinolaringologia, Argentina*

Vestibular function was systematically studied using pre and post cochlear implant vHIT. It was described that the placement of the electrode may put vestibular receptors at risk. The most widely accepted theory is a pressure increase in the internal ear causing lesion of the basilar membrane. The objectives were to evaluate the vestibular function in patients with different severe bilateral hearing loss mechanisms, and to evaluate the repercussion that the CI has on peripheral vestibular function.

It is a descriptive cross-section study performed between December 2013 and June 2015 CI was performed on adults and children with profound hearing loss from several causes at the same center and by the same surgical team. VOR gains were considered on the horizontal plane by means of vHIT. Most patients showed no variation in VOR gain. 12% presented a post cochlear implant VOR reduction, out of these 3 were children and 4 adults. Yet the 5% of patients who presented normal function of the implanted ear with a contralateral hypovalent presented bilateral peripheral vestibular dysfunction symptomatology after the implant.

- Unlike the traditional belief, bilateral hearing loss does not imply a vestibular compromise in every case
- The normality/abnormality observed in the pre-implant vHIT, is a crucial piece of information to avoid bilateral vestibular failure post CI, having to choose the worst functioning ear.
- vHIT proves to be an efficient tool to study vestibular function in a quick and safe manner, specially in pediatric population.

PP145

Clinical Testing for Vestibular Function

**ELECTRODE MONTAGE AND GAZE EFFECTS ON OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIALS (OVEMPS)****Sendhil GOVENDER**<sup>1</sup>, Petrina Y CHENG<sup>1</sup>, Danielle L DENNIS<sup>1</sup>, James G COLEBATCH<sup>1</sup><sup>1</sup>*Department of Prince of Wales Clinical School And Neuroscience Research Australia, University of New South Wales, Australia*

The conventional bipolar electrode montage has generally been used to record the ocular vestibular evoked myogenic potential (oVEMP) and consists of an active electrode placed directly beneath the eye and a reference electrode directly below it. However, few systematic investigations of other electrode montages have been carried out. In this study, we sought to map the oVEMP using several different bipolar montages and examine their changes with gaze elevation. Eighteen subjects were stimulated using air-conducted (AC) sound, midline bone-conducted (BC) vibration and transmastoid BC impulses. Five electrodes were positioned beneath the eyes (M – directly beneath the eye, L – on the outer canthus, ML – between the M and L electrodes, R – directly below the M electrode, R – directly below the ML electrode). Bipolar montages were constructed offline using these five locations.

The conventional (M-R), M-R, ML-R, and ML-R montages all showed increases in amplitude with gaze elevation. However, the ML-R montage produced the largest oVEMP amplitudes overall and this was observed across all 3 stimulus modalities. The relationship with gaze elevation was more linear for the ML-R montage compared to the conventional montage. Similar to the conventional montage, laterality of the oVEMP response was observed using the ML-R montage for AC sound and transmastoid BC impulses.

A slightly lateral (ML) active electrode could be utilised for oVEMP recordings. This is particularly relevant for the AC oVEMP as it is valuable in the detection of vestibular disease but generally harder to elicit, particularly in older subjects.

PP146

Clinical Testing for Vestibular Function

**NORMATIVE DATA AND MEASUREMENT ERROR OF VERTICAL VISUAL ACUITY TESTING IN ADULTS**

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To determine normative data for the vertical dynamic visual acuity test (vDVA) 221 asymptomatic adults, age 20 to 83, performed a static visual acuity test (SVA) and visual acuity testing on treadmill (vDVA) at different speeds (3, 4, 6 and 9 km/hr). Dynamic visual acuity loss (DVAL) was defined as the decline in logMAR score (SVA – vDVA). Main effects of age, gender and walking speed on DVAL were investigated by a general linear model ( $p < 0.05$ ). Seventy-four adults were retested to determine the DVAL measurement error (mean difference between test and retest  $\pm 2$  times the standard deviation of the differences).

Main effects were found for age ( $p < 0.001$ ) and for walking speed ( $p < 0.001$ ). Post hoc analysis revealed no significant differences in DVAL at 3 and 4 km/hr. DVAL scores (mean  $\pm$  standard deviation) for people aged  $< 40$  at different speeds were:  $0.00 \pm 0.05$  (3 km/hr;  $n = 105$ ),  $0.03 \pm 0.05$  (6 km/hr;  $n = 105$ ),  $0.06 \pm 0.05$  (9 km/hr;  $n = 105$ ). People in their forties and fifties scored:  $0.01 \pm 0.06$  (3 km/hr;  $n = 64$ ),  $0.04 \pm 0.06$  (6 km/hr;  $n = 63$ ),  $0.06 \pm 0.10$  (9 km/hr;  $n = 52$ ). For people aged  $\geq 60$  scores were:  $0.03 \pm 0.08$  (3 km/hr;  $n = 52$ ),  $0.04 \pm 0.09$  (6 km/hr;  $n = 30$ ),  $0.12 \pm 0.12$  (9 km/hr;  $n = 16$ ). Measurement error at 3 km/hr was  $0.02 \pm 0.13$  ( $n = 74$ ),  $0.02 \pm 0.13$  at 6 km/hr ( $n = 67$ ) and  $0.00 \pm 0.11$  at 9 km/hr ( $n = 55$ ).

These results show that DVAL increases with age and walking speed, with measurement errors rarely exceeding 0.15.

PP147

Clinical Testing for Vestibular Function

**VIDEO HEAD IMPULSE TESTING; WHAT INFORMATION DOES IT PROVIDE IN ACUTE AND IN CHRONIC VESTIBULAR DISEASE?**

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Video head impulse testing is an accurate method of documenting impairment of the vestibular system in acute vestibular attacks, and is also helpful in ruling out the possibility of central pathology in the clinical setting. These patients always go through a process of either recovery or compensation. Compensation is a process which is often effective, but in some patients does not take place to an adequate degree, and a patient can at times be left with lingering symptoms and impairments. In some patients with chronic symptoms the VHIT is normal or near normal, showing normal VOR gains no detectable overt/covert saccades. We have wondered if the actual “gain recovery” might be as a result of covert saccades being made so effectively that they serve to “return the gain” to unity. Although this may be seen as a drawback of the video HIT test, we see it as a useful tool for measuring the stage and the effectiveness of the compensation process. We report on a series of patients with caloric reductions. We took careful histories in these patients and correlated the time since acute attack with the VHIT results. We will report and analyze this data and discuss the correlations between “time since acute attack” and “VHIT results”. Because of this, we feel that calorics are still a necessary aspect of a diagnostic workup, and a normal HIT test in the presence of a caloric reduction will help to reassure the patients that compensation is proceeding effectively.

PP148

Clinical Testing for Vestibular Function

**SPLenius CAPITIS OFFERS A RELIABLE TARGET FOR MEASUREMENT OF THE CVEMP IN A SIMPLE STANDING POSTURE**Aaron J CAMP<sup>2</sup>, Chao GU<sup>1</sup>, Sharon L CUSHING<sup>3</sup>, Karen A GORDON<sup>3</sup>, **Brian D CORNEIL**<sup>1</sup><sup>1</sup>*Department of Physiology & Pharmacology; Psychology, University of Western Ontario, Canada*<sup>2</sup>*Department of 2department of Sydney Medical School, University of Sydney, Australia*<sup>3</sup>*Department of Of Otolaryngology – Head And Neck Surgery, The Hospital For Sick Children, Canada*

The cervical VEMP (cVEMP) provides a simple clinical test of vestibulospinal reflex patency. cVEMPS are usually measured from sternocleidomastoid (SCM) while subjects maintain a supine posture where the head is flexed ~30 degrees. This clinical posture can be challenging for children, the elderly, or patients. Here we characterize the cVEMP in a dorsal neck turner (Splenius Capitis; SPL), and compare it with the cVEMP recorded from the SCM.

cVEMPs were recorded simultaneously from SCM (via surface EMG) and SPL (via surface and intramuscular EMG) from 10 normal subjects, in response to loud tone bursts (125 dB SPL, 500 Hz, 4 ms delivered at 7.4 Hz, 30–60 s total). Comparisons were made in the clinical posture, and in standing postures with the head turned 45, 60 or 90 degrees horizontally.

As expected, SCM cVEMPs were characterized by a brief negativity at ~13 ms. Similarly, the contralateral SPL (a synergistic head turner) was also characterized by a surface negativity at similar latencies, and this was associated with a brief decrease in intramuscular activity. cVEMP reliability was higher on SPL versus SCM in the 90 degree standing postures (chi squared;  $p < 0.05$ ), and in the standard clinical posture (chi-squared;  $p = 0.06$ ). Our results demonstrate that SPL offers an alternative, complimentary, and possibly superior target for cVEMP assessments. In particular, cVEMPs on SPL can be recorded in a simple standing posture, making it an attractive target to improve patient comfort and compliance in the clinic.

PP149

Clinical Testing for Vestibular Function

**THE NORMAL VALUE AND CLINICAL MEANING OF CVEMP IN YOUTH VOLUNTEERS****Hong LU**<sup>1,2</sup>, Qiaomei DAI<sup>1</sup>, Junna HE<sup>1</sup>, Xiaopei LIU<sup>1</sup>, Caiyun ZHAO<sup>1</sup>, Aiyong LI<sup>1</sup>, Jianwei SONG<sup>1</sup><sup>1</sup>*Department of Ent & Hn Surgery Department, Shou Da E.n.t. Hospital of Beijing, China*<sup>2</sup>*Department of E.n.t & H.n Surgery Department, The 2nd Hospital of Hebei Medical University, China*

Vestibular-evoked myogenic potential had been tested for 96 volunteers using the MCU-90 auditory brainstem evoked potential instrument made by otometrics company in Denmark, those volunteers are male 25 and female 69, aged from 16 to 29 years, average age is 24 years old. The test time was from Oct. 2013 to Mar. 2014. The normal value had been established at our laboratory in ShouDa E.N.T. hospital of Beijing. Which are as follows: The threshold is 98dBnHL; the latent period p13 is  $12.8 \pm 2.6$  ms; n23 is  $21.3 \pm 3.0$  ms; the P31/n23 is  $125 \pm 65$  uv; the asymmetric rate (AR) is  $11.71 \pm 8.62$  ( $\leq 34\%$ ), p13 is more repeatability than n23; There were not tested for p34 and n44. Those values are very important for diagnosis, treatment and estimating prognosis about vertigo diseases.

PP150

Clinical Testing for Vestibular Function

**EVALUATION OF INJURED RANGE OF VESTIBULAR SUPERIOR AND INFERIOR NERVES USING VIDEO HEAD IMPULSE TEST****Peng LIN**<sup>1</sup>, **Xi HAN**<sup>1</sup>, Wei WANG<sup>1</sup>, Kaixu XU<sup>1</sup>, Lingxiao HOU<sup>1</sup>, Shanshan LI<sup>1</sup>, Qiang LIU<sup>1</sup>, Chao WEN<sup>1</sup>, Taisheng CHEN<sup>1</sup>, Peng LIN<sup>1</sup><sup>1</sup>*Department of Otolaryngology Head And Neck Surgery, Tianjin First Central Hospital, China*

**Objective:** To evaluate the application value of impulse test Video-Head (VHIT) in the assessment of superior vestibular nerve and inferior vestibular nerve function.

**Methods:** There were 60 cases of healthy volunteers as control group. The study group consisted of 168 patients with Meniere's disease, sudden deafness with vertigo, hunt syndrome or vestibular neuritis. Control group only do vHIT and study group have to do vHIT and caloric test.

**Results:** VHIT of the control group were all normal. In study group, the caloric test note that 138 patients with horizontal semicircular canal function decline. 141 patients have one or more semicircular canal injury by vHIT. Among these patients, three semicircular canal abnormal in the lesion ear is 39 cases, 12 cases had abnormal anterior semicircular canal and horizontal semicircular canal, 9 cases had posterior semicircular canal and horizontal semicircular canal abnormal. Patients with single semicircular canal abnormal of horizontal, anterior or posterior is 42, 28 and 11. According to the results of the vHIT and vestibular nerve region analysis, 48 cases had superior vestibular nerve and inferior vestibular nerve damaged, 82 cases with superior vestibular nerve damage, 11 cases with inferior vestibular nerve damage. There was no significant difference in the results of caloric test with vHIT.

**Conclusion:** VHIT result is objective, convenient and practical. It can assess the function of six semicircular canals and identify the damage of the superior vestibular nerve or inferior vestibular nerve. It has important value in the assessment of vestibular damage location in patients with vertigo.

PP151

Clinical Testing for Vestibular Function

### COMPARING THE BEDSIDE HEAD IMPULSE TEST WITH THE VIDEO HEAD IMPULSE TEST IN 500 OUTPATIENTS

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**Objectives:** To determine 1) the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and 2) the inter-rater reliability, of the bedside head impulse test (bHIT) using the video HIT (vHIT) as the benchmark for vestibulo-ocular testing in clinical practice setting.

**Methods:** 500 outpatients with vertigo or dizziness due to various vestibular disorders were prospectively recruited. Three experienced clinicians performed the bHIT without prior knowledge of the diagnosis. Their findings were later compared with the vHIT. The pre-defined "pathological" vHIT gain used in the study was  $< 0.7$ . The sensitivity, specificity, PPV and NPV was calculated using standard methods. The inter-rater reliability was determined from the Krippendorff's alpha.

**Results:** With a "pathological" VOR gain defined as  $< 0.7$ , the mean bHIT sensitivity = 66.0%, PPV = 44.3%, specificity = 86.2% and NPV = 93.9 %. Increasing the threshold for "pathological" vHIT gain from 0.6 to 0.9 would reduce the sensitivity and increase the PPV of the bHIT, while the specificity and NPV tended to remain stable. The inter-rater agreement was average (Krippendorff's alpha = 0.54).

**Conclusions:** The bHIT has at most moderate sensitivity but low PPV when the a reference "pathological" gain was  $< 0.7$ . However, the sensitivity and PPV changes with the user-defined threshold of the "pathological" vHIT gain. A normal bHIT is good at ruling out a significant VOR deficit. The interpretation of the bHIT is subject to individual variability. Therefore, the vHIT is a useful adjunct to improve the diagnostic sensitivity or PPV of the bHIT.

PP152

Clinical Testing for Vestibular Function

### VIDEONYSTAGMOGRAPHY INFORMING HEAD POSITION USING AN INFRARED CAMERA AND A MOTION-TRACKING SENSOR

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Videonystagmography (VOG) with an infrared camera is now commonly used to examine nystagmus, instead of the Frenzel glass. The feature of this system is that the video image can be stored and evaluated later. The direction

of nystagmus depends on head position in patients with benign paroxysmal positional nystagmus; therefore, the position of the head during VOG is important. However, commonly used systems cannot do that. The purpose of this study was to develop a low cost and compact VOG system informing head position.

We developed a software and specific goggle. Head animation images based on data from the sensor were overlaid on nystagmus images from the camera using the software. The goggle, which included the infrared camera and motion-tracking sensor, was designed and developed using a three-dimensional printer. This goggle was very compact and light. The data of the head position and the images from the camera were connected by a USB cable to a computer. The system did not require any additional hardware and could be used on a laptop computer; therefore, it can be used both at bedside and at house calls.

Here, we explain the construction of the goggle with the motion sensor device and camera, and the use of our software that allows overlaying of head animation images onto nystagmus images and enables utilization of recorded images in various ways.

PP153

Clinical Testing for Vestibular Function

### **OTONEUROLOGICAL STUDY OF BILATERAL VESTIBULAR FUNCTION LOSS**

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Bilateral vestibular failure causes movement-dependent postural vertigo, unsteadiness of gait, and in serious cases patients complain of blurred vision while walking (known as the jumbling phenomenon). This condition is defined as bilateral vestibulopathy (BV) and its diagnostic criteria have been proposed previously. The purpose of this retrospective study is to clarify the relationship between the vestibular failure tested by both the caloric test and video Head Impulse Test (vHIT), and the presence of symptoms characteristic to BV. A total of 210 patients were included in the study period. Eight patients showed bilateral absent caloric responses of the ice-water caloric test. Among these 8 patients, only 3 patients complained of the jumbling phenomenon and this symptom well correlate with vHIT abnormality. vHIT did not show bilateral profound vestibular deficit in other 5 cases who were without jumbling phenomenon. These results indicate that the abnormal caloric responses per se does not have clinical significance to diagnose BV. Suspected BV patients should be tested by the combination of 2 test batteries (the ice-water caloric test and vHIT) to make a proper diagnosis.

PP154

Clinical Testing for Vestibular Function

### **SUBJECTIVE VISUAL VERTICAL DURING STATIC HEAD ROLL TILT TO QUANTIFY GRAVITY PERCEPTION**

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We developed a clinical examination to quantify gravity perception as a first step to test our hypothesis that gravity perception disturbance causes dizziness. Our preliminary experiments revealed a linear relationship between head tilt angle (HTA) and head tilt perception (HTP) in less than 30° of head roll tilt, with correlation coefficients of 0.991 and 0.999 between HTA and HTP in the whole body and head tilt conditions, respectively. Using these observations, we established a method to evaluate the HTP gain (HTPG), which is the slope of a linear regression line produced by the subjective visual vertical (SVV) with HTA during head tilt, as an index of gravity perception. We named this method head tilt SVV (HT-SVV). When HTPG > 1, the subject's HTP overestimates his/her HTA, and vice versa. HT-SVV measurements of 329 healthy subjects led the average and standard deviation ( $1.02 \pm 0.12$ ) and reference value (0.80–1.25) of HTPG, the difference between the left and right HTPG ( $4.7 \pm 3.7\%$ , < 10.0%), and the absolute value of SVV in the upright head position ( $1.1 \pm 0.8^\circ$ , < 2.5°). In addition, we show some HT-SVV data of patients experiencing dizziness.

PP155

Clinical Testing for Vestibular Function

**CALORIC EXPONENTIAL DECAY – A NEW PARAMETER OF CALORIC TEST**Jeonghui JOO<sup>1</sup>, Hyerin KWON<sup>1</sup>, Mi Joo KIM<sup>2</sup>, Nam Beom KIM<sup>3</sup>, Gyu Cheol HAN<sup>1</sup><sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea*<sup>2</sup>*Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea*<sup>3</sup>*Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea*

**Introduction:** Binaural bi-thermal caloric test is the most typical one in vestibular function testing. Although the canal paresis (CP, %) is often calculated by the ratio of peak velocity found in nystagmus under the binaural bi-thermal caloric test, vibration induced nystagmus (VIN, deg/s), and slow harmonic acceleration test (SHA test) do not correlate with CP indeed with DHI, spontaneous nystagmus (SN, deg/s).

**Method:** Forty-six patients were diagnosed with acute vestibular neuritis participated in this study. (Male and female ♂: ♀= 24 + 22 and mean age 54.7 ± 15.2, range 20–84). We compared the time constant (Tc) of caloric nystagmus by calculating the applicability of collected data such as phase, gain, and computerized posturography (CDP) from DHI, SN, VIN, and SHA test.

**Results:** Although negative correlation shown between the Tc of alternate binaural bi-thermal caloric test and the SN, it was not statistically consequential. The value showed higher positive correlation ( $r^2 = 0.62-0.89$ ) in VIN, and SHA test showed statistically negative correlation close to the borderline ( $r^2 = 0.34-0.32$ ) in low frequency. In CDP under conditions of 4, 5, and 6, the composite score showed statistically significant data with  $r^2 = 0.39, 0.37, 0.36, 0.60$ .

**Conclusion:** The methods using Tc in classical caloric test proves meaningful correlation with other vestibular function testing; it could be used as supportive variable to diagnose subjective dizziness.

PP156

Clinical Testing for Vestibular Function

**IPSI-LESIONAL HYPERVENTILATION-INDUCED NYSTAGMUS IN A PATIENT WITH LABYRINTHINE HEMORRHAGE**Seong-Hae JEONG<sup>1</sup>, Jae Moon KIM<sup>1</sup>, Hyunjin JO<sup>1</sup><sup>1</sup>*Department of Neurology, Chungnam National University Hospital, Korea*

**Purpose:** Ipsilesional hyperventilation-induced nystagmus (iHIN) is commonly observed in patients with cerebellopontine angle tumor. To date, there has been no report on iHIN in labyrinthine hemorrhage.

**Method:** Detailed neurotological evaluations were performed.

**Results:** A 75-year-old woman presented with first ever severe vertigo and imbalance for 1 day. There was no trauma history. She has suffered from hypertension. Initial vital signs were 210/87-77-35.4°. Examination showed rightward ocular tilt reaction. Spontaneous left and upbeat nystagmus was augmented by leftward gaze, head-shaking and positioning maneuver. However, the leftward spontaneous nystagmus converted to rightward after hyperventilation for 30 s. Head impulse test demonstrated catch-up saccade during rightward impulse. Rightward falling tendency was observed. Other neurological examination was normal including cerebellar function test. Caloric weakness at 74% was shown in the right ear. Subjective visual vertical were 1.5 OD, 3.7 OU, and 2.8 OS. Ocular vestibular evoked myogenic potential to bone stimuli was decreased in the right ear (amplitude asymmetry index ratio 17.7%). Ocular/Cervical vestibular evoked myogenic potential to air stimuli was not observed bilaterally. Pure tone audiometry demonstrated symmetric high tone loss in both ear. T1 high signal of right vestibule on internal auditory canal MRI was suggestive of the labyrinthine hemorrhage. Other routine serological finding was unremarkable.

**Conclusion:** This case suggests the iHIN could be another hallmark in patients with labyrinthine hemorrhage.



PP157

Clinical Testing for Vestibular Function

**AGE-RELATED CHANGES IN CERVICAL VESTIBULAR EVOKED MYOGENIC POTENTIAL**Sung Kyun KIM<sup>1</sup>, Kijeong LEE<sup>1</sup>, Yoon Chan RHA<sup>1</sup>, Hak Hyun JUNG<sup>1</sup>, **Gi Jung IM<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Korea University College of Medicine, Korea*

**Objectives:** The purpose of the this study was to define for young, middle-aged, and older adults the optimal reference to record the cervical vestibular-evoked myogenic potential (cVEMP). Further, present investigation aimed to describe age-related changes in the cVEMP.

**Methods:** Participants were 30 healthy adults (mean age  $49.0 \pm 17.6$  years; 60 ears) equally divided into 3 age groups of 10 participants each: young adult (20–39 years), middle age (40–59 years), and old adult ( $\geq 60$  years). cVEMP was recorded using air-conducted sound stimuli consisted of 500 Hz, 95 dB SPL tone bursts with a linear envelope (1 ms rise/fall time, 2 ms plateau), at a repetition rate of 5 Hz. Analysis of variance (ANOVA) was used to evaluate whether cVEMP latency, amplitude and asymmetry ratio differed significantly among age groups.

**Results:** The peak-to-peak amplitude of the cVEMP varied with age group. The mean amplitude for the young adult age group was significantly larger than that for both the middle age and old adult age groups. In contrast, no significant differences were found for p13 and n13 latency among the age group and each side. Age was significantly associated with measures of saccular dysfunction.

**Conclusion:** The results of this investigation have shown that age-related changes of amplitude of cVEMP should consider for interpretation of results and detection of abnormal range of latency need to further evaluation for central lesions. Further studies are in progress to establish the clinical and functional correlates of these age, sex- and race-based differences in VEMP results.

PP158

Clinical Testing for Vestibular Function

**THE SIGNIFICANCE OF NEGATIVE SACCADES IN VIDEO HEAD IMPULSE TEST**Thi Anh Dao NGUYEN<sup>1</sup>, Jang-Woo KWON<sup>1</sup>, Hyun-Ji KIM<sup>2</sup>, Sangmin LEE<sup>3,4</sup>, Dae-Young KIM<sup>2</sup>, **Kyu-Sung KIM<sup>2,4</sup>**<sup>1</sup>*Department of Computer and Information Engineering, Inha University, Incheon, Korea*<sup>2</sup>*Department of Otolaryngology-Head & Neck Surgery, Inha University Hospital, Incheon, Korea*<sup>3</sup>*Department of Electronic Engineering, Inha University, Incheon, Korea*<sup>4</sup>*Institute for Information and Electronics Research, Inha University, Incheon, Korea*

**Objectives:** Video head impulse test (vHIT) was innovated to replace the inaccurate manual head impulse test, and the cumbersome scleral search coil (SSC) technique. Nevertheless, health professionals are uncertain about vHIT's potential diagnostic due to the artifacts caused by goggle slippages and other reasons. One of those are negative saccades, the eye movements in the direction opposite to the desired target, resulting in the declination of the compensation of the eye movement to the head movement. Therefore, it might be the trigger to the following overt catch-up saccades but is neglected in the interpretation of result and also in clinical decision. Therefore, this study aimed to give the perception of vHIT by introducing the investigation of negative saccades with detailed analysis.

**Methods:** The targeted group of this study is the subjects diagnosed with vestibular neuritis, and twenty-four datasets from patients were examined. (17 female, 7 male, with a mean age of 51.6, range 22–80), in which 17 datasets are with right lesion, and seven others is with left lesion. The recording device is ICS Impulse (GN Otometrics, Taastrup, Denmark).

**Results:** Catch-up Saccades was found in this sample 83.3%, in which covert catch-up saccades (CCSs) 38.4%, overt catch-up saccades (OCSs) 75.3%, both CCSs and OCSs 30.4%, isolated covert catch-up saccades (iCCSs) 8.0%, and isolated overt catch-up saccades (iOCSs) 44.9%. The negative saccades (NS) followed by OCSs were found at the rate of 40.0%, at  $119 \pm 8$  ms with  $-45 \pm 27$  deg/sec. The OCSs and iOCSs following NS have the higher latency ( $213 \pm 20$  ms,  $211 \pm 20$  ms) and the higher amplitude ( $105 \pm 88$  deg/sec,  $88.96 \pm 85$  deg/sec) respectively compared to the latency ( $201.53 \pm 20$  ms,  $203 \pm 20$  ms) and the amplitude ( $91 \pm 75$  deg/sec,  $78 \pm 72$

deg/sec) of total population of OCSs and of iOCSs. In addition, the result also showed that the OCS compensation to negative saccades is likely to zero, for both normal and isolated OCSs. Hence, it might just use for compensating the previous negative saccades.

**Conclusions:** Negative saccades in vHIT decline the compensation of the eye movement to the head movement by vestibulo-ocular reflex. Therefore, they might be the reason for overt catch-up saccades to occur or overestimate, and then should be included in diagnosis claim.

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PP159

Clinical Testing for Vestibular Function

### HEAD POSITION AND INCREASED HEAD VELOCITY TO OPTIMIZE VIDEO HEAD IMPULSE TEST SENSITIVITY

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**Objective:** This study investigated the effects of head position on gain values during video head impulse tests (vHITs).

**Methods:** Different head positions were used for vHIT of the horizontal semicircular canals of 20 healthy controls and 18 patients with unilateral vestibular loss (UVL), with head velocities ranging from 150 to 200 degrees/sec. Differences in vestibulo-ocular reflex gain in the control and patient groups according to head position (0 and 30-degree downward pitch) were analyzed.

**Results:** In the unaffected control group, the 30-degree pitched-down position resulted in a mean gain increase of up to 1.0 in both ears (right ear:  $0.85 \pm 0.26$  for head-up and  $1.05 \pm 0.12$  for head-down,  $p = 0.004$ ; left ear:  $0.75 \pm 0.18$  for head-up and  $0.98 \pm 0.16$  for head-down,  $p < 0.001$ ). In patients with UVL, the mean gains on the diseased side were  $0.92 \pm 0.16$  in the head-up position and  $0.82 \pm 0.2$  in the head-down position, at similar head velocities ( $p = 0.046$ ). The pitched-down position also increased the asymmetry between ears in patients with UVL, at the same head velocity.

**Conclusion:** A 30-degree head-down position can increase vHIT sensitivity, which resulted in increased mean gain in unaffected people and decreased mean gain in most of the patients with UVL in this study. This method may more effectively stimulate the horizontal semicircular canal. This vHIT modification may be helpful for more precisely evaluating vestibular function, thus reducing false-negative findings.

PP160

Clinical Testing for Vestibular Function

### OTOTOXICITY FROM ORGANIC SOLVENTS ASSESSED BY AN INNER EAR TEST BATTERY

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**Objective:** This study adopted an inner ear test battery comprising audiometry, and ocular vestibular-evoked myogenic potential (oVEMP), cervical VEMP (cVEMP) and caloric tests to assess inner ear function in patients with long term exposure to organic solvents.

**Methods:** Eighteen patients exposed to organic solvents and another 18 non-exposed controls from the same environment were enrolled in this study. Each subject underwent an inner ear test battery.

**Results:** The percentages of abnormalities identified by the oVEMP test, cVEMP test, audiometry and caloric test for the exposed group were 85%, 54%, 50% and 33%, respectively, which showed significant differences when compared with the respective 8%, 8%, 6% and 0 for the non-exposed group. Additionally, a significantly declining trend of inner ear deficits from the utricle to the saccule, cochlea, and semicircular canals was noted in the exposed group, but not in the non-exposed group.

**Conclusion:** Ototoxicity was identified in those exposed to organic solvents, with the sequence of abnormal inner ear function from the utricle to the saccule, cochlea, and semicircular canals.

PP161

Clinical Testing for Vestibular Function

**CHIARI TYPE I MALFORMATION PRESENTING WITH GAZE-EVOKED DIRECTION CHANGING NYSTAGMUS: A CASE REPORT.**

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**Objective:** To recognize gaze-evoked direction changing nystagmus as a clinical presentation of Arnold-Chiari malformation which will result in appropriate imaging testing and treatment.

**Background:** Arnold-Chiari malformations typically present with occipital migraine (90%), neck pain, arm pain, numbness and weakness, vertigo, disequilibrium (77%), tinnitus and visual changes. Nystagmus in Arnold-Chiari malformations are usually described as downbeat nystagmus. Gaze-evoked direction changing nystagmus indicates central nervous system involvement and are not commonly found in Arnold-Chiari malformations.

**Case:** A 31-year-old female with no significant past medical history presented with vertigo, imbalance and oscillopsia for 2 months. Symptoms were minimal at rest, lasting minutes, accentuated with mobility attempts or position changes.

The examination was suggestive of central vestibular dysfunction: pure right torsional nystagmus accentuated with right gaze, left beating nystagmus with left gaze with fixation present. Hallpike testing showed burst of downbeating nystagmus for 10 seconds with oscillopsia. Brain showed Chiari Malformation type 1 with cerebellar tonsils herniation of 15 millimeters below the opisthion-basion line.

**Results:** In the setting of no other cranial nerve or neurological findings and normal brainstem on MRI, the central nystagmus was attributed to Arnold-Chiari type I malformation. This approach prompted surgical correction of Arnold-Chiari malformation with decompressive craniectomy which resulted in improvement of symptoms.

**Conclusion:** This case illustrates the importance of recognizing gaze-evoked direction changing nystagmus as clinical manifestation of Arnold-Chiari malformations leading to an accurate diagnosis and appropriate treatment. Its presence creates a list of differential diagnosis that includes posterior fossa dysfunction and may not initially include Arnold-Chiari malformation.

PP162

Clinical Testing for Vestibular Function

**THE VERTICAL COMPUTERIZED ROTATIONAL HEAD IMPULSE TEST (VERTICAL CRHIT)**

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**Introduction:** The video head impulse test (vHIT), which uses manually delivered head rotations, has been advocated as a method to assess both the horizontal and vertical semicircular canals. Problems with vertical canal testing using the vHIT include the difficulty rotating the head precisely in the vertical canal planes and the small position excursion permitted by oblique head-on-torso motion.

**Objectives:** We aimed to assess the ability of a computerized whole-body rotational head impulse test (crHIT), a new test of semicircular canal function, to be used in the evaluation of the vertical semicircular canals.

**Methods:** Vertical crHIT used whole-body, computer-controlled, earth-vertical axis rotation with a peak velocity of 150 deg/sec and a peak acceleration of 750 deg/sec/sec followed by a gradual deceleration. The head was positioned precisely so that the LARP or RALP plane was earth-horizontal. VOR sensitivity for each vertical semicircular canal was estimated using the ratio of vertical eye velocity to vertical head velocity. The vertical crHIT was evaluated in a small group of control subjects.

**Results:** Results showed that the vertical crHIT was well-tolerated by all subjects. The VOR sensitivity for each of the four vertical semicircular canals was measured for each subject successfully.

**Conclusions:** The vertical crHIT has the advantages of eliminating neck movement, using a less abrupt movement, allowing random magnitude and direction of rotation, avoiding the small position limitations of a head-on-torso rotation, and eliminating the need for a highly trained examiner. The crHIT represents a higher technology approach to the well-established head impulse test.

PP163

Cochlear Implant and Vestibular Function

**DIZZINESS AFTER COCHLEAR IMPLANTATION**

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**Introduction:** Cochlear implantation (CI) is a well-known surgical procedure to rehabilitate the profound hearing loss. Postoperative dizziness and vertigo is one of common complications of cochlear implantation.

**Objectives:** The reported prevalence of dizziness after cochlear implantation is varies between different scientific papers. The aim of this study is to determine the reported postimplantation outcome in terms of dizziness.

**Materials and Methods:** The study population was composed of 80 patients who submitted to cochlear implantation at the Keimyung University, Dongsan Medical Center.

**Result:** Dizziness was evident in 25% of the population post-CI. The dizziness was mild in most of the patients.

**Conclusion:** CI is a safe surgery with few major complications, it is a procedure that can produce dizziness. Therefore, in patients who will be undergoing CI, counselling the dizziness preoperatively is valuable.

PP164

Cochlear Implant and Vestibular Function

**SOME RESULTS AFTER CI SURGERY PATIENTS WITH TINNITUS IN MONGOLIA**

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**Introduction:** Cochlear implant surgery started to be operated in Mongolia since 2009 (Cochlear Co.Ltd). The company performed the CI surgery to 5 post lingual deaf patient with tinnitus in 2009–2016. All 5 patients were implanted with electrode including 2 cases CI 422, 1 case pc CI 512 and 2 cases Nucleus CI 24 RE. Average age of the 3 patients were 27–43 years. 2 patients were 14–15 years old. First recipient who was operated in 2009 could distinguish most sounds after 6 months of the operation and they could cooperate with family and could sing 1–2 songs 3 years later. 4 months later after the operation most patients began to hear sounds and after 6 months later they knew their names and one years later they could say some monosyllabic Mongolian few words. 4 patients tinnitus were disappeared in implanted side. One patient's tinnitus wasn't disappear.

**Conclusion:** Implanting Cochlear implant to the profound, deaf tinnitus patients are able to realistically rehabilitate hearing loss and tinnitus disappear.

Key word: deaf, profound hearing loss, cochlear implant, tinnitus, Nucleus 5

PP165

Epidemiology

**PHENOTYPE OF EPISODIC VESTIBULAR SYNDROMES (PEVS) – A PROSPECTIVE MULTICENTER EUROPEAN STUDY**

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**Objective:** Differential diagnosis of episodic vestibular syndromes (EVS) is a challenge in neurotology and largely based on history-taking. The objective of the present study was to analyze the phenotypes of EVS (PEVS) in order to identify the points discriminating patients with Menière's disease (MD), probable and definite vestibular migraine (p- and dVM).

**Methods:** 423 patients with EVS were recruited (MD:  $n = 119$ ; pVM:  $n = 66$ ; dVM:  $n = 84$ ). EVS with vertigo attacks of at least 5 min not fulfilling the criteria for MD/VM were classified as "not otherwise specified" (NOS;  $n = 58$ ). Patients with TIA, panic attacks, vestibular paroxysmia and BPPV were not included in this study.

**Results:** Despite an overlap of symptoms, the four subgroups presented with certain distinct symptom clusters, e.g. positional vertigo symptoms were much more common in p/dVM (42/48%) than MD (3%). The group of NOS patients was characterized by a lack of "typical" accompanying symptoms observed in MD (tinnitus, fullness of ear, hearing loss) and VM (photo-/phonophobia and migraine-type headache). The histograms for attack duration showed a peak between 1–4 hours in MD, a double peak for dVM (6–60 min/1–3 days) and a plateau for pVM (up to 1 day). NOS patients displayed small peaks for attack durations < 1 min and 5–24 hours. Furthermore, exacerbations of symptom intensity within attacks were more common in dVM (58%) than MD (25%).

**Conclusion:** The results of this study provide further clues which could be helpful for the differential diagnosis between spontaneous vestibular syndromes like MD, pVM and dVM.

PP166

Epidemiology

#### **RELATIONSHIP BETWEEN SARCOPENIA AND STATIC POSTUROGRAPHY: IN THE KOREAN NATIONAL HEALTH & NUTRITION SURVEY IN 2010**

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**Background:** Sarcopenia is called as a loss of muscle volume in human body. Sarcopenia is a major component of the frailty syndrome and is also a strong predictor of disability, and mortality in older persons. The relationship between sarcopenia and the result of static posturography (foam test) was not studied.

**Method:** In this study, we organized the Korean national health & nutrition exhibition survey in 2010 and we defined sarcopenia using ASM index and also measured dizziness using foam test, dizziness questionnaires. We analyzed relationship between sarcopenia and dizziness and calculated sensitivity and specificity of foam test. We also analyze the difference in incidence rate of dizziness in age and sex.

**Results:** The results shows people with low ASM index which means the sarcopenic condition tend to get dizziness easily than those with normal muscle mass. This result were same in analysis using dizziness questionnaire and analysis using foam test. Also, the incidence rate of dizziness questionnaire is higher in female than male. The sarcopenia condition of female increase the poor performance in static posturography.

**Conclusion:** In this study, the relationship between sarcopenia and static posturography results shows the sarcopenia increase the incidence of fall rate of static posturography. The fall group of static posturography of sarcopenia shows higher positive rate in prevalence of dizziness questionnaires. The result means higher frequency of dizziness prevalence in people with low muscle mass than normal muscle mass.

PP167

Functional and Psychiatric Vestibular Disorders

#### **DIZZINESS AND DEMENTIA –TWO CASE STUDIES–**

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**Introduction:** Japan is a hyperaging society. The number of patients with dementia are increasing and might be 4.62 million people in 2012. We reported patients with dizziness and dementia. [Subjects] Out of 951 patients (304 men, 647 women, age range, 4-95; mean age  $60.3 \pm 18.1$  years), 50 patients (12 men, 38 women) had dementia.

**Case reports:** Case 1 was 86-year-old woman. She had forgetfulness, irritability and delusion of theft in 2001. She came our hospital in 2005. She had vertigo, hearing loss and left-beating nystagmus in 2006, and received the therapy of anti-vertigous drugs and hearing aid. Her revised Hasegawa's dementia scale (HDS-R) was 16/30. Case 2 was 71-year-old woman. She had severe dizziness and anxiety and came our hospital in 2010. She wanted to receive physical therapy for her diabetes, but her blood glucose level was 449. Her HDS-R was 14/30.

**Discussion:** Patients with dementia may have balance disorders or hearing loss but they sometimes did not recognize. We are trying to treat them using collaborative approach in both otolaryngologic and psychiatric methods.

PP168

Functional and Psychiatric Vestibular Disorders

### **FREQUENCY PROPERTIES OF POSTURAL SWAY IN PERSISTENT POSTURAL AND PERCEPTUAL DIZZINESS**

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**Purpose:** To assess the frequency characteristics of postural instability in patients with persistent postural and perceptual dizziness (PPPD) in comparison with those with idiopathic bilateral vestibulopathy (IBV).

**Methods:** 27 patients with IBV, 66 patients with PPPD, and 194 healthy controls were included. Two-legged stance tasks were performed in 4 conditions: eyes open with and without foam rubber, and eyes closed with and without foam rubber. We normalized frequency distribution provided by maximum entropy method from 0.01 Hz to 10 Hz every 0.5 Hz about the anterior-posterior and the left-right direction. We regarded power beyond averages  $\pm 2SD$  of healthy controls as abnormal.

**Results:** In PPPD patients, postural abnormalities were observed at lower frequencies (especially in 0.01–0.5 Hz) in all four conditions, which was remarkable in the conditions without foam rubber. On the other hand, in IBV patients, postural abnormalities were observed in widespread frequencies in the conditions with eyes closed with and without foam rubber.

**Conclusion:** The frequency power spectrum analysis of postural stability is useful for the differentiation between PPPD and IBV.

PP169

Gait, Posture, and Locomotion

### **CORTICAL NETWORK ACTIVITIES DURING POSTURAL BALANCE IN SENSORY CONFLICT –FNIRS STUDY–**

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**Background and aim:** To investigate network correlations among the vestibular, frontal, and parietal cortices during postural balancing in sensory conflict, we performed functional connectivity analyses for the cortical hemodynamic responses recorded with functional near infrared spectroscopy (fNIRS) during Sensory Organization Test (SOT) as part of the EquiTest System.

**Methods:** Eleven male healthy subjects were enrolled (all right-handed). 31 NIRS probes (15 optical sources and 16 detectors) were set on the right parieto-temporal head surface and hemodynamic data were recorded from 50 fNIRS channels. A band pass Fourier filter (0.01–0.1 Hz) in the raw time series of the Oxy-Hb signals was used

to remove long-term baseline drift and higher frequency cardiac or respiratory activity. After these processes, we calculated cross-correlations of NIRS signals between all possible pairs of regions of interest (ROIs) in each subject. We calculated mean coefficients among all subjects in each pair of ROIs and mapped mean coefficients  $> 0.6$  as significant functional connectivity in each SOT.

**Results:** There were two high connectivity networks, one among the peri-Sylvian cortices and ventral premotor cortex (peri-Sylvian network) and one between the posterior parietal cortex and frontal motor-related cortex (parieto-frontal network). These two networks converge on the supramarginal gyrus (SMG).

**Conclusion:** The peri-Sylvian network may function to detect sensory conflict and sensory reweighting and send the reweighted sensory information to the SMG. The parieto-frontal network may function for integration based on reweighted sensory information, spatial reorientation, and the selection and planning of motor behaviors.

PP170

Gait, Posture, and Locomotion

### POSTURAL SENSORY CORRELATES OF FREEZING OF GAIT IN PARKINSON'S DISEASE

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**Introduction:** To elucidate the unique patterns of postural sensory deficits contributing to freezing of gait (FOG) in patients with Parkinson's disease (PD) and to identify postural sensory modalities that correlate with FOG severity.

**Methods:** Twenty-five PD patients with FOG, 22 PD patients without FOG, and 26 age-matched controls were evaluated using a sensory organization test and clinical measures including the Unified Parkinson's Disease Rating Scale motor score, Montreal Cognitive Assessment, Frontal Assessment Battery, Activities-specific Balance Confidence, Beck Anxiety Inventory, Beck Depression Inventory, and Berg Balance Scale. Multivariable logistic regression analysis was performed for posturographic parameters and possible confounders to determine postural sensory contributors to FOG. We also correlated FOG severity, measured using a New Freezing of Gait Questionnaire, with posturographic parameters.

**Results:** PD patients with FOG showed worse postural sensory processing compared with those without FOG. In particular, the inability to use the vestibular information (odds ratio [OR] 1.447; 95% confidential interval [CI]: 1.120, 1.869) and poor control over the perturbed somatosensory inputs (OR 2.904; 95% CI: 1.028, 8.202) significantly contributed to FOG. Among PD patients with FOG, FOG severity was correlated with higher reliance on visual information ( $\rho = -0.432$ ,  $p = 0.039$ ).

**Conclusions:** Postural sensory deficits involving specific sensory modalities are strongly associated with FOG. Quantitative measurement of postural sensory deficits in PD patients with FOG may provide a better understanding of pathomechanisms of FOG and increase the efficacy of sensory cueing strategies for alleviating FOG, by more accurately identifying suitable patients for rehabilitative therapies.

PP171

Genetics, Development, and Regeneration

### COMPREHENSIVE VESTIBULAR FUNCTIONS OF HEREDITARY HEARING LOSS PATIENTS WITH GJB2 MUTATIONS.

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**Objectives:** Mutations in the GJB2 gene have been of particular interest as it is the commonest causative gene for congenital deafness in all populations. Detailed audiological features including genotype-phenotype correlations have been well documented. However, in spite of abundant gene as well as protein expression in the vestibular end organs, neither vestibular symptoms nor vestibular functions have yet been elucidated. In the present study, vestibular functions were evaluated in patients diagnosed with GJB2 -related deafness.

**Subjects and Methods:** Vestibular functions were evaluated by the caloric test and cervical vestibular evoked myogenic potential (cVEMP) and ocular VEMP (oVEMP) in 26 patients with biallelic GJB2 mutations.

**Results and Discussion:** Twenty-four (92%) of 25 patients, and all of the patients had normal responses in the caloric test and oVEMP, respectively. However, the corrected amplitude of cVEMP for the patients with GJB2 mutations was statistically lower ( $p < 0.001$ , Mann-Whitney U test) than that of the age-matched normal controls. In the patients who were able to undergo vestibular testing, the mostly normal reactions to caloric testing and oVEMP indicated that the lateral semicircular canal and utricular function were intact. However, the majority of GJB2 patients showed low cVEMP reactions, indicating a saccular defect.

PP172

Genetics, Development, and Regeneration

**EYE MOVEMENT AND VESTIBULAR DYSFUNCTION IN MITOCHONDRIAL A3243G MUTATION**

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Studying eye movements and vestibular function would provide insights on brain networks that are vulnerable in mitochondrial disorders. We sought eye movement and vestibular abnormalities in three Korean patients with a mitochondrial A3243G point mutation. Two patients with cerebellar atrophy on neuroimaging showed bilateral impairments of the vestibulo-ocular reflex during head impulses for the horizontal and posterior canals on both sides in the absence of caloric paresis. In addition, the patients suffered from vertigo and imbalance during the stroke-like and seizure episodes from lesions involving the posterior cerebral cortex, which were accompanied by bilateral saccadic hypermetria and horizontal gaze-evoked nystagmus. These findings imply that the cerebellum is susceptible to neuronal energy deficiency due to mitochondrial A3243G point mutation.

PP173

Imaging of the Inner Ear and Vestibular System

**ACUTE COCHLEAR-VESTIBULAR SYNDROME: CHARACTERISTICS, PROGNOSIS AND CARE**

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The new techniques of functional examinations and the improvement of MRI make it possible to better characterize the cochleo-vestibular deficiencies. The aim of this work is to describe a population presenting a cochleo-vestibular syndrome, to explain the initial clinical and para-clinical characteristics and follow their progress for 6 months, by distinguishing two groups by MRI: the first group with an abnormal labyrinthine FLAIR signal (FLAIR+) and the second group with a normal labyrinthine FLAIR signal (FLAIR-).

Thirty-one patients were included. They received a symptomatic treatment associated with a general corticotherapy and local trans-tympanic injections of dexamethasone. Eighteen patients presented a spontaneous increase FLAIR signal. Among those FLAIR+ patients. The FLAIR- patients ( $n = 13$ ) were older and had a higher cardiovascular risk factor than FLAIR+ patients. No difference was noticed between both groups as far as average hearing loss, calorics hyporeflexia, cVEMP and VHIT for the initial assessment. After 6 months there was a significant improvement of the hearing loss among the FLAIR+ patients, but not among the FLAIR- patients.

Nine FLAIR+ patients received a corticoid bolus because of a persistent dizziness: 8 of them neatly improved their dizziness, without any difference on the hearing loss recovery. The MRI became normalized for 2 patients who received the bolus.

Two profiles seem to emerge: the patients showing an increase FLAIR signal and responding to the anti inflammatory treatment, and the FLAIR- patients who show a lower hearing loss recovery and for whom a microvascular etiology may be considered.



PP174

Imaging of the Inner Ear and Vestibular System

**EVALUATION OF HIGH JUGULAR BULB IN COMPUTED TOMOGRAPHY OF PATIENTS WITH MENIERE'S DISEASE.**Ryohei OYA<sup>1</sup>, Takao IMAI<sup>2</sup>, Atsuhiko UNO<sup>3</sup>, Tadashi KITAHARA<sup>4</sup>, Suzuyo OKAZAKI<sup>1</sup>, Hidenori INOHARA<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Osaka University Graduate School of Medicine, Japan*<sup>2</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Osaka Rosai Hospital, Japan*<sup>3</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Osaka General Medical Center, Japan*<sup>4</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Nara Medical University Hospital, Japan*

**Purpose:** Endolymphatic hydrops is widely recognized as a main pathologic cause of Meniere's disease (MD) and recently endolymphatic hydrops can be detected by enhanced MRI. But the etiological cause of endolymphatic hydrops is still unclear. The past study reported the relationship between MD and high jugular bulb (HJB). In this study we analyzed the CT in MD patients and investigated the presence of HJB.

**Methods:** During July 2009 to December 2015, 60 patients with severe MD who required an operation and showed endolymphatic hydrops in enhanced MRI participated in this study. We also analyzed 68 patients with otosclerosis or facial palsy as control. We defined HJB that the apex of JB was higher than the round window in an axial view of CT.

**Results:** The presence of HJB was found in 22 out of 60 affected ears in MD patients and found 18 non-affected ears. The agreement between the affected side and HJB located side was not different from the chance level. In control group HJB was found in 51 out of 132 ears, and this wasn't also significant. (Chi square test).

**Discussion:** In this study we found no difference about HJB in both groups. Therefore we think there is no relationship between HJB and endolymphatic hydrops. We experienced the case who had HJB which disturbed vestibular aqueduct and recovered by sac operation. If HJB caused hydrops, endolymphatic decompression should have no effect because endolymphatic sac located in more peripheral than HJB. So our study agrees with such a case.

PP175

Imaging of the Inner Ear and Vestibular System

**A ONE YEAR AUDIT: INITIAL MAGNETIC RESONANCE IMAGING RESULTS IN 328 CASES OF ASYMMETRICAL SENSORINEURAL HEARING LOSS**Jui May YONG<sup>1</sup>, Crystal CHEONG<sup>1</sup>, Edward SEAH<sup>3</sup>, Leonora LIU<sup>2</sup>, Raymond NGO<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Head And Neck Surgery, National University Hospital, Singapore*<sup>2</sup>*Department of Yong Loo Lin School of Medicine, National University of Singapore, Singapore*<sup>3</sup>*Department of School of Medicine, Monash University, Australia*

**Introduction:** Most otolaryngologists consider it the standard of care to refer a patient with asymmetrical sensorineural hearing loss (SNHL) for a magnetic resonance (MRI) evaluation to exclude a cerebellopontine angle (CPA) tumor. However, it is acknowledged that this practice yields low positive rates and brings high costs to the health care system. We sought to study the detection rate for CPA lesions with this practice.

**Methods:** We obtained data on all the MRI scans of the internal acoustic meatus from October 2013–2014 in a single institution. We then reviewed the subgroup who presented to the otolaryngology clinic with asymmetrical SNHL on pure tone audiometry. We excluded patients who had follow-up MRI scans for known problems or other reasons.

**Initial results:** A total of 473 MRI studies were done in the analysed period. Out of these, 328 (69.3%) were done for a presentation of asymmetrical SNHL. 10 of the studies in this subgroup were abnormal (0.03%). 7 of the 10 studies detected a CPA lesion. Age range for patients diagnosed with a CPA lesion was 39–64 with a mean of 51.1 and average difference between both sides on audiometry was 37.9 dB.

**Discussion:** From our initial results, the detection rate of CPA lesions on MRI done for asymmetrical SNHL is extremely low at 0.02%. However, all MR imaging that detected CPA lesions were done for asymmetrical SNHL. Ongoing analysis on the degree of asymmetry to predict which patients would benefit from an MRI is being carried out.

PP176

Imaging of the Inner Ear and Vestibular System

**CLEARING OF THE MOUSE TEMPORAL BONE FOR IMAGING****Tomoko MAKISHIMA**<sup>1</sup>, Rebecca COOK<sup>1</sup>, Naoki SHIMIZU<sup>1</sup>, Adrian PERACHIO<sup>1</sup><sup>1</sup>*Department of Otolaryngology, University of Texas Medical Branch, USA*

**Purpose of the study:** Histological and anatomical studies of the mouse inner ear are technically difficult due to its small size and its location embedded in the temporal bone. A recently published protocol, SeeDB (Nat Neurosci 16:1154-1161, 2013), allows the clearing and the visualization of a whole brain in mice in a 3D fashion. We hypothesized that modification of tissue clearing protocols will enable clearing the mouse temporal bone and cartilage to be suitable for immunofluorescent labeling. Our goal was to achieve 3D visualization of inner ear organs encased in the temporal bone.

**Methods:** Temporal bones were dissected from mice at ages ranging from postnatal day 1 (P1) to P30. The SeeDB protocol was modified. Briefly, the adult temporal bones were decalcified before starting the process. The cartilaginous temporal bone of younger mice was processed directly without decalcification. After fixation in 4% paraformaldehyde in PBS, the samples were labeled with hair cell-specific markers and fluorescent dyes. Then the samples were incubated in a series of fructose solutions with increasing concentrations. Samples were mounted and viewed using fluorescent microscopy.

**Results:** Successful clearing of cartilaginous temporal bone and partial clearing of decalcified temporal bone was achieved. We were able to reconstruct the sensory epithelia in the vestibule in a 3D fashion.

**Conclusion:** Our modified protocol was low-cost using readily available materials. We were able to clear and visualize mature mouse temporal bones. We hope to optimize the protocol for immunofluorescent labeling that is specific to the individual inner ear cell populations.

PP177

Meniere's Disease and Related Disorders

**IMAGING OF 3D-FLAIR MRI AFTER INTRATYMPANIC GD ADMINISTRATION IN MENIERE'S DISEASE WITH ENDOLYMPHATIC SAC SURGERY****Daogong ZHANG**<sup>1</sup>, Zhaomim FAN<sup>1</sup>, Honglu SHI<sup>2</sup>, Yawei LI<sup>1</sup>, Yafeng LV<sup>1</sup>, Yuechen HAN<sup>1</sup>, Guangbin WANG<sup>2</sup>, Haibo WANG<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Provincial Hospital Affiliated To Shandong University, Jinan, China*<sup>2</sup>*Department of Magnetic Resonance Spin Resonance, Shandong Medical Imaging Research Institute, China*

**Objective:** To study the change of endolymphatic hydrops of Meniere's disease patients with endolymphatic sac surgery by applying intratympanic gadolinium administration through the tympanic membrane and three-dimensional fluid-attenuated inversion recovery magnetic resonance imaging (3D-FLAIR MRI).

**Methods:** With a 3 Tesla magnetic resonance imaging (MRI) unit, 3D-FLAIR imaging was performed 24 hours after intratympanic gadolinium through the tympanic membrane in 11 patients with clinically diagnosed unilateral Meniere's Disease with endolymphatic sac surgery. We visualized the enhanced imaging of perilymphatic space in bilateral cochlea, vestibular and (or) canal, scoring scala tympani and scala vestibule of bilateral cochlear basal turn respectively and measuring the developing area of bilateral vestibule. The change of imaging before surgery and 2 years after surgery was analysed.

**Results:** The gadolinium appeared in almost all parts of the perilymph in cochlea, vestibular and (or) canal in all 11 patients' inner ears. The scala vestibular score values between the affected side and the healthy side were statistically significant ( $Z = 3.426$ ,  $P < 0.05$ ). The developing area of bilateral vestibular [(5.76 ± 2.99) mm<sup>2</sup>, (8.89 ± 2.52) mm<sup>2</sup>] between the affected side and the healthy side were statistically significant ( $t = 2.65$ ,  $P < 0.05$ ). The scala vestibular score values were not statistically significant when compared before and after surgery in both the affected side or the healthy side ( $Z = 0.447$ ,  $P > 0.05$ ;  $Z = 0.0$ ,  $P > 0.05$ ). The developing vestibular areas were not statistically significant when compared before and after surgery in both the affected side or the healthy side ( $t = 0.74$ ,  $P > 0.05$ ;  $t = 0.66$ ,  $P > 0.05$ ).

**Conclusion:** The endolymphatic hydrops was not ameliorated after endolymphatic sac surgery. The mechanism of endolymphatic sac surgery might not through reducing hydrops.

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Meniere's Disease and Related Disorders

**MONITORING OF CHEMICAL LABYRINTHECTOMY BY GENTAMICIN USING VHIT IN PATIENTS SUFFERING FROM MENIERE DISEASE**

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**Aims and introduction:** Chemical labyrinthectomy by intratympanic injection of Gentamicin is an interesting alternative treatment of the vestibular neurotomy for patients suffering from Meniere disease resistant to medical treatment. In this work, we studied: 1. How many injections are needed? 2. Is there an improvement of horizontal VOR gain at long post-lesioned stage (2 years)?

**Patients and methods:** 20 patients suffering from Meniere disease had weekly gentamicin injections (80 mg/2 ml, 1 to 3 injections). They were tested before injections by vHIT, caloric test, cervical and ocular VEMPs, and hearing test. Balance was assessed using Equitest and Wii plus foam. Just before a new injection, canal function was assessed by vHIT in order to follow the VOR decrease and ocular nystagmus was measured using video-nystagmography. Patients were followed longitudinally at 1, 3 and 6 months, 1 and 2 years after the last injection.

**Results and conclusions:** The necessary number of injections to induce effective unilateral vestibular loss varied between patients: some patients needed only one injection; others needed two or three injections. Our functional test data gave clear indication about the effect of gentamycin injections with time. VHIT showed a decreased vestibulo-ocular reflex gain in horizontal and vertical canal planes. Ocular VEMPs were also crucial indicators to assess the gentamicin-induced utriculo-ocular dysfunction. In conclusion, monitoring vestibular function using vHIT and VEMPs before each injection allowed us to define specific criteria to detect signs of effective vestibular loss and determine the necessary number of intratympanic injections.

PP179

Meniere's Disease and Related Disorders

**THE RELATIONSHIP BETWEEN HEAD-SHAKING NYSTAGMUS AND THE SHORT-TERM PROGNOSIS OF HEARING LOSS IN MENIERE'S DISEASE**

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Meniere's disease (MD) is clinically characterized by recurrent attacks of vertigo, tinnitus, (fluctuating) hearing loss, and a sense of fullness in the affected ear. Many studies have explored the long-term outcomes of hearing loss in MD patients, but very few articles have addressed the short-term outcomes. We investigated the relationship between the head-shaking nystagmus (HSN) pattern, evident prior to treatment, and the short-term outcomes of hearing loss, of patients with unilateral MD.

The medical records of a total of 113 patients diagnosed with unilateral MD were retrospectively reviewed. The hearing level at the time that hearing loss was initially detected, and the best hearing level attained within the next 6 months, were compared. The first HSN phase was evaluated, prior to treatment, with Frenzel's glasses. We divided all subjects into three groups by reference to the HSN results: an ipsilesional HSN (ipsi-HSN) group; a contralesional HSN (contra-HSN) group; and a group without significant HSN [HSN (-)]. Patients with persistent spontaneous nystagmus were excluded. The HSN patterns were ipsi-HSN in 21 patients, contra-HSN in 25, and HSN (-) in 67. The hearing outcomes after treatment were "cured or better" in 18, 19, and 65 ipsi-HSN, contra-HSN, and HSN (-)

cases, respectively; and “no change or worse” in 3, 6, and 2 such cases. The number of patients scored as “no change or worse” was significantly larger in the contra-HSN group than the HSN (-) group (Steel-Dwass statistics,  $p < 0.05$ ). Thus, concomitant contralesional HSN may predict the hearing loss outcome of MD patients.

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Meniere's Disease and Related Disorders

### VOR RESPONSE OF SEMICIRCULAR CANALS IN MENIERE'S DISEASE: CALORIC TEST AND VIDEO HEAD IMPULSE TEST

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**Purpose:** To investigate the vestibulo-ocular reflex (VOR) response of semicircular canals in Meniere's disease with the results of caloric test and video head impulse test (vHIT), and the relationships with the clinical characteristics.

**Method:** 38 patients of unilateral definite Meniere's disease were included. Bithermal caloric test and vHIT in the plane of 6 semicircular canals were performed. Results of caloric test were compared with horizontal canal vHIT, and the relationships between canal functions and clinical characteristics (disease duration, hearing loss) were evaluated.

**Result:** The deficit of vHIT in any of three canals from affected ear was observed in 6 (15.8%) patients. Among these 6 patients, both of horizontal canal and posterior canal were abnormal in 4 patients, and only posterior canal was abnormal in 2 patients. Caloric response was paralytic in 28 patient (73.7%) and there was a discrepancy between caloric test and horizontal canal vHIT in 24 patients (63.2%). In all patients with the deficit of vHIT, caloric responses were paralytic. Patients with the deficit of vHIT had longer duration of disease than patients with normal vHIT. Both of disease duration and hearing threshold were not correlated with the paralysis of caloric response.

**Conclusion:** In Meniere's disease, VOR response of semicircular canals for high acceleration is more preserved than thermally induced very low frequency VOR response. VOR deficit on vHIT is not uniform between different canals in each patient and is dependent on the duration of disease.

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Meniere's Disease and Related Disorders

### VESTIBULAR CHARACTERISTICS IN FOUR STAGES OF MENIERE'S DISEASE

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**Purpose:** We investigated the subjective dizziness severity and objective vestibular functions to compare the impact of vestibular dysfunction across the four stages of Meniere's disease.

**Methods:** Clinical data of the patients with definite Meniere's disease were reviewed retrospectively. The stage has been established based on the four-tone average of the pure-tone thresholds at 0.5, 1, 2, and 3 kHz before treatment applying the 1995 guidelines of the AAO-HNS Committee on Hearing and Equilibrium. VNG, VEMP, rotatory chair test (RCT), and computerized dynamic posturography (CDP) were performed. The patients completed the dizziness questionnaire, dizziness handicap inventory (DHI).

**Results:** Subjects were 20 men aged mean 52.5 years and 40 women aged mean 58.4 years. Stage 1/2/3/4 comprised 18/14/23/5 patients. The degree of caloric weakness and DHI did not differ among the groups. The proportions of those who have caloric weakness in VNG, interaural amplitude difference in VEMP, decreased gain/phase abnormality in RCT, and vestibular dysfunction in CDP did not demonstrate significant differences across the four groups. Asymmetry in RCT was more frequent in stages 3 and 4 than in stages 1 and 2 ( $p = 0.008$ ), suggesting impaired vestibular compensation in chronic disease. Notably, DHI scores were similar between the subjects with and without caloric weakness.

**Conclusion:** These results suggest that the stages of Meniere's disease do not significantly influence both the subjective severity and objective status of the vestibular system. In addition, subjective dizziness distress may not be correlated with the degree of vestibular dysfunction of the affected ears.

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Meniere's Disease and Related Disorders

**INTENSIVE SALT-RESTRICTION EDUCATION & MEASUREMENT OF 24-HR URINARY SODIUM EXCRETION IN THE ELDERLY WITH DIZZINESS**Yong Kyung KANG<sup>1</sup>, Hyun Joon SHIM<sup>1</sup>, Jin Hyun JUN<sup>2</sup>, Jeong Min AHN<sup>3</sup>, Jeong Don CHAE<sup>4</sup>, Young-Hwan HWANG<sup>5</sup>, **Yong-Hwi AN<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology-head And Neck Surgery, Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea*<sup>2</sup>*Department of Eulji Medi-bio Research Institute, Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea*<sup>3</sup>*Department of Nutrition And Dietetics, Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea*<sup>4</sup>*Department of Laboratory Medicine, Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea*<sup>5</sup>*Department of Internal Medicine, Eulji Medical Center, Eulji University School of Medicine, Seoul, Korea*

**Objective:** To investigate whether salt intake, measured by 24-h urinary sodium excretion, is an independent risk factor for the older adults with dizziness and whether low salt diet through strict salt-restriction education has an effect on dizziness in the elderly.

**Methods:** We prospectively followed 45 patients with idiopathic dizziness and 33 subjects without vertigo aged 65–79 years. Overall, 36 of 78 participants were enrolled for analysis of complete and reliable data. Questionnaires, otologic and neurologic exam, audiometry, vestibular function test, and electrocochleography were performed in all participants. Intensive education on salt-restriction was randomly assigned. Clinical evaluation and 24-h urine was followed-up 1, 3, 6, and 12 months after initial visit.

**Results:** There was no significant difference of 24-h urinary sodium excretion between dizziness ( $N = 21$ ) and control ( $N = 15$ ) groups. Four (22.2%) of 18 subjects who were intensively educated on salt-restriction indicated proper low salt diet in 24-h urine. Subjective improvement of dizziness in the 11 patients with intensive salt-restriction education was not different from that in 10 patients without education. No significant relation was found between 24-h urinary sodium and following variables: age, duration and severity of dizziness, questionnaire scores, presence of nystagmus, pure tone average, and SP/AP ratio.

**Conclusion:** 24-hr urine is a clinically useful tool to evaluate the sodium intake but has high drop-out rate. Urinary sodium and low salt diet showed no remarkable correlation with the dizzy elderly in this study population. Further studies are required for application of 24-h urinary sodium excretion to patients with Meniere's disease.

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Meniere's Disease and Related Disorders

**EXPLORATORY TYMPANOTOMY AND GENTAMICIN INFILTRATION: ITS APPLICATION AND RESULT IN MÉNIÈRE'S DISEASE**Yoon Chan RAH<sup>1,2</sup>, Jae Joon HAN<sup>1</sup>, Byung Yoon CHOI<sup>1</sup>, **Ja-Won KOO<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea*<sup>2</sup>*Department of Otorhinolaryngology, Korea University Ansan Hospital, Korea*

**Purpose:** To evaluate the potential application of exploratory tympanotomy and gentamicin infiltration (ETG) and its result for intractable Ménière's disease (MD)

**Method:** A total of seven patients who suffered from intractable vertigo even after medical and surgical treatment (Class F, Intratympanic gentamicin injection = 6, Meniette = 1) were included. The changes of vertigo, hearing, associated problems, subsequent treatment options were analyzed according to the 1995 AAO-HNS guideline.

**Results:** Among seven patients who got ETG, six patients got 3.5 rounds of ITG in average prior to ETG, however, the vestibular function was not sufficiently attenuated in four of six patients. After ETG, five of seven (71.4%) patients whose vestibular function was attenuated substantially achieved class A including a patient who previously used Meniette device. However, the remaining two patients, whose caloric functions were not sufficiently attenuated, needed subsequent labyrinthectomies. During ETG, prominent bony overhang over round window niche was found in three cases. Average pre-ETG pure tone threshold was  $78.1 \pm 36.0$  and changed to  $79.3 \pm 37.7$  with a case of more than 10 dB worsening (12.5 dB).

**Conclusion:** ETG may be a reasonable option to facilitate the delivery of gentamicin into the inner ear by direct application of gentamicin over the round possibly overcoming anatomical limitations in the middle ear.

PP184

Meniere's Disease and Related Disorders

**VESTIBULAR SCHWANNOMA (VS) MIMICKING THE SYMPTOMS OF MENIERE'S DISEASE: A RETROSPECTIVE STUDY**

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Progressive hearing loss and tinnitus represent usually the first symptoms of VS. Gait unsteadiness, dizziness or vertigo attacks are rarely reported as initial symptoms. The aim of our retrospective study was to determine patients with VS reporting the typical triad of Menière's disease (MD) and if MRI showed specific findings in correlation with MD symptoms.

Sixty patients (23 females and 37 males) aged 24 to 82 years (average 53 years) were studied. Neurological examination included PTA, BEAP, c-VEMP, ENG. MRI 3D-CISS sequence were analyzed in terms of tumor volume, infiltration of the cochlear aperture, as well as signal loss of the membranous labyrinth, cochlea and vestibule.

Out of 60 patients, 11 (18.3%) suffered from typical triad of MD. MRI was available within 4 patients: 3 women, 1 man, aged from 60 to 74 years; 2 VS on right side. Koss classification grade 1 ( $n = 2$ ), grade 2 ( $n = 1$ ), grade 3 ( $n = 1$ ). Tumor volume ranged from 14.13 to 1502.72 mm<sup>3</sup>.

MRI showed any signal loss of cochlea and vestibule. Infiltration of cochlea aperture was present within 1 patient. No significant correlation was found between MRI findings and triad of MD.

**Conclusion:** 3D-CISS is appropriate for observing inner ear signal loss in patients with VS. Among patients with typical triad of MD, MRI showed any specific findings. Physiopathological mechanism might be due to variation of pressure within perilymphatic spaces and/or homeostatic changes between peri- and endolymphatic compartments. Prospective studies using 3D-FLAIR/3D-real IR MRI might be powerful to evaluate this clinical aspect of VS.

PP185

Ocular Motility: Physiology and Pathology

**CROSSED VERTICAL GAZE PALSY IN CADASIL**

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Crossed vertical gaze palsy refers to a rare combination of elevation paresis in one eye and depression palsy in the fellow eye. It was once reported in a patient with unilateral infarction involving the mesodiencephalic junction, and was ascribed to selective disruption of the fibers projecting from the rostral interstitial nucleus of the medial longitudinal fasciculus (riMLF) to the oculomotor nuclear complex. Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) is a rare cause of ophthalmoplegia and crossed vertical gaze palsy has not been described in this disorder. Our patient with a circumscribed acute infarction involving the left mesodiencephalic junction due to CADASIL showed both upward and downward gaze palsy in both eyes, but more marked depression paresis in the ipsilesional eye and more conspicuous elevation deficit in the contralesional eye, which was consistent with crossed vertical gaze palsy. We provide alternate explanation for this rare phenotype of vertical gaze palsy. Crossed vertical gaze palsy may be a manifestation of CADASIL.

PP186

Ocular Motility: Physiology and Pathology

**THE THIRD DIMENSION OF OUR SIXTH SENSE****Johannes VAN DER STEEN**<sup>1</sup>, Johan PEL<sup>1</sup><sup>1</sup>*Department of Neuroscience, Erasmus Mc, Netherlands*

The vestibular system provides ocular and postural compensation for movements in 3D space. However, current Intra red eye tracking techniques are still not fully capable to record 3D eye movements.

In humans we previously investigated 3D oculomotor compensation with search coils during 3D vestibular stimulation using a hexapod motion platform. In these studies we have shown that gain and misalignment varies as a function of stimulus axis. In particular the lower gain torsion has implications for 3D compensation in terms of gain and misalignment.

In the current study we investigated the effect of different types of vestibular dysfunction on 3D compensatory eye movements. In a case of vestibular neuritis we found long-term effects (> 3 years) on torsional eye movement component, resulting in abnormal 3D compensation. In 6 cases of Schwannoma we also observed abnormal 3D compensation. In another case damage to the nucleus of Cajal also resulted in almost absent torsional compensation. We conclude that impairments to torsional compensatory eye movements occur relatively frequent and therefore should be part of 3D VOR testing. With the increasing use of infra red of video eye trackers in vestibular testing it is tempting to limit testing to horizontal and vertical compensatory eye movements. However, there should be effort to develop techniques to record 3D eye movements with the IR technique.

PP187

Other Vestibular Disorders

**DIFFERENTIAL DIAGNOSIS OF VERTIGO IN CHILDREN****Berina IHTIJAREVIC**<sup>1,2</sup>, Sebastien JANSSENS DE VAREBEKE<sup>1</sup>, Katrien KETELSLAGERS<sup>1</sup>, Kristof DEBEN<sup>1,2</sup>, Charlotte COLPAERT<sup>1</sup>, Tony COX<sup>1</sup>, Josine WIDDERSHOVEN<sup>1,3</sup><sup>1</sup>*Department of Otorhinolaryngology & Head And Neck Surgery, Jessa Hospital Hasselt, Belgium*<sup>2</sup>*Department of Medicine And Health Sciences, University of Antwerp, Belgium*<sup>3</sup>*Department of Otorhinolaryngology & Head And Neck Surgery, Maastricht University Medical Centre, Netherlands*

**Introduction and aim:** The differential diagnosis of vertigo in children is extensive. Many causes of vertigo in children are benign and self-limiting, still the diagnosis is considered challenging. The aim of this study was to detect the most common causes of vertigo in children and to create an overview of how to examine and diagnose children with vertigo and/or suspicion of vestibular dysfunction.

**Material and methods:** A retrospective study was performed on 67 children presenting at our Otorhinolaryngology vestibular outpatient clinic; 33 boys and 34 girls aged 0 to 17 years. History taking, clinical examination and audiological testing were obtained. If needed further investigations were done by video/elektronystagmography, neurologic examination, serologic testing and/or imaging.

**Results:** The most common causes of vertigo in children were migraine related syndromes (24%) such as benign paroxysmal vertigo in children and migraine. Thirteen percent were investigated pre and post-cochlear implantation. Twelve percent developed vertigo attacks post-infectiously. Ten percent presented with vertigo after a skull base fracture or commotio cerebri. None was diagnosed with BPPV. Only 9% developed vertigo caused by otitis media with effusion. Screening for vestibular dysfunction showed motor delay with (7.5%) or without hearing loss (18%). Additionally in 3% imaging showed circumstantial findings of vestibular pathologies. Finally one child (1.5%) underwent vestibular testing because of suspected CHARGE syndrome.

**Conclusions:** Migraine related syndromes were the most frequent cause of vertigo. A combination of history taking and clinical examination is necessary to determine the importance of further investigations and to differentiate vestibular pathologies in children.

PP188

Other Vestibular Disorders

**A COMPARATIVE STUDY EVALUATING THE UTILITY OF EGF, FGF-2, AND OFLOXACIN DROPS TO TREAT TRAUMATIC TMPs****Zhengcai LOU***Department of Otorhinolaryngology, Yiwu Central Hospital, China*

**Objective:** We compared the effects of epidermal growth factor (EGF), fibroblast growth factor-2 (FGF-2), 0.3% (w/v) ofloxacin drops, and conservative observation (only), on the healing of human traumatic tympanic membrane perforations (TMPs).

**Study design:** A prospective, randomized, controlled clinical study. **Subjects and Methods:** All patients had traumatic TMPs covering > 25% of the entire tympanic membrane. The closure rates, closure times, and rates of otorrhoea in patients who were treated with EGF, FGF-2, or 0.3% (w/v) ofloxacin drops, and who underwent conservative observation only, were compared.

**Results:** At the 6-month follow-up, the closure rates did not significantly differ among the groups ( $P = 0.170$ ). Similarly, pairwise comparisons did not reveal any significant between-group differences ( $P > 0.0083$ ). The mean closure time differed significantly among the four groups ( $P < 0.001$ ); pairwise comparisons showed that the mean closure time was significantly longer in the observational group than in the test groups ( $P < 0.001$ ). However, no significant difference in mean closure time was evident between any two experimental groups ( $P > 0.0083$ ).

**Conclusion:** Topical application of EGF, FGF-2, and ofloxacin drops accelerated the closure of large human traumatic TMPs. Surprisingly, neither the closure rate nor closure time differed significantly among the three test groups. This results indicate that topical application of ofloxacin drops aids in the healing of traumatic TMPs and should be considered as an alternative treatment option.

PP189

Other Vestibular Disorders

**THE DIZZINESS HANDICAP INVENTORY (DHI) DOES NOT CORRELATE WITH VESTIBULAR DYSFUNCTION****Chun Wai YIP**<sup>1,2</sup>, Michael STRUPP<sup>1</sup><sup>1</sup>*Department of Neurology, German Center For Vertigo And Balance Disorders, University Hospital Munich, Campus Grosshadern, Munich, Germany, Germany*<sup>2</sup>*Department of Neurology, National Neuroscience Institute, Singapore General Hospital Campus, Singapore, Singapore*

**Objective:** To correlate the DHI and its subscores with quantitative tests of vestibular function in patients with various vestibular disorders, and determine whether median DHI was significantly different between vestibular disorders.

**Methods:** Outpatients with dizziness were prospectively enrolled from the Vertigo Centre, University Hospital of Munich. The vestibulo-ocular reflex (VOR) was tested by the video head impulse test (vHIT) and caloric irrigation. Otolith function was tested by the cervical and ocular vestibular-evoked myogenic potentials (VEMP). All patients filled-up the DHI questionnaire. The correlation coefficient ( $r$ ) between the DHI and each test was determined. The median DHIs of each disease group was evaluated using the the Kruskal-Wallis test for significant differences.

**Results:** Interim analysis of 164 patients showed no significant correlation between DHI and 1) VOR function in the high frequency (left vHIT:  $r = 0.078$ , right vHIT:  $r = 0.018$ ) or low frequency range (caloric-induced total peak slow phase velocity:  $r = 0.036$ , unilateral weakness:  $r = 0.199$ ); 2) VOR asymmetry ( $r = 0.049$ ); 3) Asymmetry ratios of the oVEMP ( $r = 0.008$ ) or cVEMP ( $r = 0.021$ ). Similarly, there was no correlation between the DHI subscores and any of the vestibular tests. The median DHIs of each disease group (total 8 groups consisting central, peripheral, and functional dizziness) were not significantly different ( $p = 0.584$ ).

**Conclusions:** Neither the DHI nor its subcomponents correlated with quantitative vestibular function. The DHI is not a sensitive indicator for vestibular dysfunction and/or bears no correlation with measurable vestibular deficits. Median DHIs did not differentiate between various vestibular disorders.



PP190

Other Vestibular Disorders

**ASSESSMENT OF RELATIONSHIP BETWEEN DIZZINESS AND SLEEP DISTURBANCE USING THE PITTSBURGH SLEEP QUALITY INDEX****Ujimoto KONOMI**<sup>1,2</sup>, Mamoru SUZUKI<sup>2</sup>, Yasuo OGAWA<sup>2</sup>, Koji OTSUKA<sup>2</sup>, Tarou INAGAKI<sup>2</sup>, Noriko NAGAI<sup>2</sup><sup>1</sup>*Department of Otorhinolaryngology, Kohsei Chuo General Hospital, Japan*<sup>2</sup>*Department of Otorhinolaryngology, Tokyo Medical University, Japan*

**Purpose:** This study was performed to determine the frequency and degree of sleep disturbance in patients with dizziness using the Pittsburgh Sleep Quality Index, Japanese Version (PSQI-J), and investigate the relationship between dizziness and sleep disturbance.

**Methods:** Two hundred thirty six patients (94 male, 142 female) with a chief complaint of dizziness visited the dizziness clinic of the Department of Otolaryngology, Tokyo Medical University, for 10 months in 2013. The patients' age (average  $\pm$  standard deviation) was  $53.7 \pm 18.1$  years (range, 7–96 years). PSQI-J was tested on their first visit of dizziness clinic.

**Results:** The average PSQI global score was  $6.8 \pm 3.8$  points, which exceeds the 5.5-point cut-off for insomnia. In total, 58.9% of patients scored  $> 6$  points, and 31.4% scored  $> 9$  points, indicating definite sleep disturbance. With respect to the demography of disease groups, patients with autonomic imbalance scored an average of 8.0 points, and those with psychogenic dizziness scored 10.3 points; all of these diseases were associated with high PSQI scores. Patients with benign paroxysmal positional vertigo and patients with Meniere's disease showed relative high scores (6.8 and 6.4 points, respectively). Patients with suspected sleep apnea syndrome, restless leg syndrome, and parasomnias tended to show high scores.

**Conclusion:** A high rate and high grade of sleep disturbance were confirmed in patients with dizziness, indicating that sleep quality affects several types of dizziness and vertigo. Understanding sleep disorders is helpful for the diagnosis and treatment of dizziness and provides a new perspective on the etiology of dizziness.

PP191

Clinical Testing for Vestibular Function

**UNKNOWN POSITIONAL VERTIGO WITH THE DEFICIT OF VERTICAL SEMICIRCULAR CANAL ON VIDEO HEAD IMPULSE TEST****Seungchul LEE**<sup>1</sup>, Jeeseun CHOI<sup>1</sup>, Joongwook SHIN<sup>1</sup>, Hoki LEE<sup>1</sup>, Hongjoon PARK<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Soree Ear Clinic, Korea*

**Purpose:** To investigate the clinical characteristics of unknown positional vertigo having the deficit of vertical semicircular canal (SCC) on video head impulse test (vHIT).

**Method:** Twenty two patients complaining of positional vertigo who had the deficit of vertical semicircular canal on vHIT without any neurological symptom were included. Patients of benign paroxysmal positional vertigo at the time of visit were excluded and patients who had history of Meniere's disease or vestibular neuritis were excluded. Clinical characteristics and vestibular tests including positional test and vHIT were reviewed.

**Result:** All of twenty two patients had the deficit of posterior SCC on vHIT. Ten patients had the deficit of anterior SCC on contralateral side and the deficit of horizontal SCC was found in one patient. For positional test, down beating nystagmus with/without torsional nystagmus was observed in nine patients in at least one position and up beating nystagmus in five patients. Cervical vestibular evoked myogenic potential was tested in one patient and it was normal. Duration of symptom was various among the patients from several days to several years. Positional vertigo was recurrent in eight patients and five patients had the history of benign paroxysmal positional vertigo. In five patients, vHIT was repeated on next visit and vHIT was normalized with the relief of vertigo in all five patients.

**Conclusion:** Some of the patients with positional vertigo could be caused by selective deficit of vertical SCC especially posterior SCC even though the cause of the deficit of vertical SCC is uncertain.

PP192

Central Vestibular Disorders

**UNILATERAL SENSORINEURAL HEARING LOSS WITH SILENT VESTIBULAR HYPOFUNCTION: A SIGN OF CEREBELLOPONTINE ANGLE TUMOR**Woongsang SUNWOO<sup>1</sup>, Yung Jin JEON<sup>1</sup>, Han Gyeol PARK<sup>1</sup>, Yoonjae SONG<sup>1</sup>, Shin Hye KIM<sup>1</sup>, Jae-Jin SONG<sup>1</sup>, Bung Yoon CHOI<sup>1</sup>, **Ja-Won KOO<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea*

**Objectives:** In patients with progressive unilateral sensorineural hearing loss (USNHL), presence of ipsilateral cerebellopontine angle (CPA) tumor should always be ruled out. Considering slowly growing nature of most CPA tumors, we can surmise that patients with CPA tumor may have ipsilateral vestibular hypofunction without any symptom due to gradual central compensation. In this regard, this study aims to investigate characteristics of CPA tumor and correlation with non-symptomatic unilateral vestibular hypofunction (UVH) in USNHL patients.

**Methods:** From January 2013 to June 2015, 257 subjects with USNHL but without history of dizziness underwent internal auditory canal or brain magnetic resonance imaging (MRI) at Seoul National University Bundang Hospital. All enrolled patients underwent pure tone audiometry, speech audiometry, and vestibular function tests (VFT). UVH was diagnosed when findings such as canal paresis  $\geq 20\%$ , positive head-shaking nystagmus or head-impulse test were present. The diameter of CPA tumor was measured on axial view of MRI.

**Results:** Among 257 USNHL subjects, 52 (20.2%) were diagnosed with CPA tumor. Of 52 subjects with CPA tumor, 43 (82.7%) had UVH while only 31 of 205 (15.1%) had UVH in patients without CPA tumor (Chi-square test,  $p < 0.001$ ).

**Conclusion:** Based on significant association between the presence of CPA tumor and non-symptomatic UVH, the possibility of CPA tumor should be considered when USNHL patients without any vestibular symptom present with UVH. Adding to conventional auditory brainstem response, VFT may be of diagnostic importance for CPA tumors in subjects with USNHL.

PP193

Functional and Psychiatric Vestibular Disorders

**UTILITY OF PSYCHOLOGICAL SCREENING FOR THE DIAGNOSIS OF PEDIATRIC EPISODIC VERTIGO****Hyung-Mi KIM<sup>1</sup>**, Young Ju KIM<sup>1</sup>, Chang Ho LEE<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Cha University, Korea*

Childhood episodic vertigo has been reported to be associated with migraine or childhood periodic syndromes such as benign paroxysmal vertigo of childhood. There is discrete evidence that unexpected recurrent vertigo is associated with a high level of depression and anxiety in adults. However, only a few studies describe the frequency and characteristics of psychiatric comorbidity in vertiginous children. The aim of this study is to evaluate the incidence and characteristics of emotional and behavioral problems using outpatient-based psychological screening tools in children with episodic vertigo attacks. A total of 105 patients and 138 controls, aged 4 to 17 years, were enrolled. All were identified with a primary complaint of recurrent episodic vertigo. All patients received a complete battery of audiological and vestibular tests. Psychological assessment was performed using standardized questionnaires, including Strength and Difficulties Questionnaire (SDQ), Children's Depression Inventory (CDI), and Screen for Child Anxiety Related Emotional Disorders (SCARED). Compared with community controls, children presenting vertigo attacks had significantly higher mean scores on almost all scales of SDQ, CDI, and SCARED, except two parameters, namely, prosocial behavior and separation anxiety. About half of the patients, compared to 10 to 11% of the controls, had significant levels of distress that could adversely impact treatment outcomes and might need psychiatric consultation. Significant distress or impairment in social interactions was more prominent in older ages. Our findings suggest that children/adolescents with recurrent episodic vertigo should be screened for possible associated psychological symptoms.

PP194

Animal Models and Molecular Approach

**CONNEXIN 43 ACTS AS A PRO-APOPTOTIC MODULATOR IN CISPLATIN-INDUCED AUDITORY CELL DEATH**Yeon Ju KIM<sup>1</sup>, Young Sun KIM<sup>1</sup>, Beomyong SHIN<sup>1</sup>, Oak Sung CHOO<sup>1</sup>, Yun-Hoon CHOUNG<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Ajou University School of Medicine, Korea*

**Background:** Gap junction(GJ) coupling may play a role for intercellular communication by the “Good Samaritan effect” or “bystander effect” under pathological conditions. Non-junctional connexins(Cxs) also may play some GJ-independent roles in cell death/survival. The purposes of this study were to investigate the role of non-junctional Cxs in ototoxic drug-induced auditory cell death and to evaluate the effect of GJ inhibitors.

**Methods:** Non-junctional Cx43 proteins in HEI-OC1 cells were prepared with three techniques. 1) Low confluence culture (5X10<sup>3</sup>/cm<sup>2</sup>). 2) Construction of short lengthened Cx43; Cx43-NT (amino acid 1–256, membrane domain), Cx43-CT(amino acid 257–382, cytoplasmic domain). 3) Brefeldin A(BFA), an ER-Golgi trafficking inhibitor. A live/dead cell viability assay and western blotting were done under knock-down conditions(siRNA-Cx43). Additionally, For animal studies, carbenoxolone (CBX, 50 mg/kg) and 18-alpha glycyrrhetic acid (18 $\alpha$ -GA, 100 mg/kg) was intraperitoneally injected to rats treated with cisplatin (16 mg/kg). Auditory brainstem response and morphologic analysis were done with immunohistochemistry.

**Results:** Knock down of non-channel Cx43(siRNA) inhibited cisplatin-induced cell death in MTT assay and Western blot. This finding was not changed by disruption of Cx43 trafficking with BFA. HeLa cells expressing the Cx43-FL(full length), Cx43-NT or Cx43-CT showed enhanced sensitivity to cisplatin compared to Mock cells. In animal studies, hearing thresholds in CBX+cisplatin-treated rats were significantly better than those in the cisplatin-alone treated rats. In SEM, loss of stereocilia in outer hair cells was much more in the cisplatin-treated rats than in the CBX+cisplatin-treated rats.

**Conclusion:** Cx43 plays a pro-apoptotic role in cisplatin-induced auditory cell death, which is either dependent or independent on GJ intercellular communications.

PP195

Other Vestibular Disorders

**ADULT PATIENTS WITH TYPE 2 DIABETES MELLITUS MAY HAVE A DECREASED UTRICULAR FUNCTION.**Kathrine JAUREGUI-RENAUD<sup>1</sup>, Catalina ARANDA-MORENO<sup>1</sup>, Aline B. HERRERA-RANGEL<sup>1</sup><sup>1</sup>*Unidad de Investigación Médica en Otoneurología, Instituto Mexicano del Seguro Social, Mexico*

**Background:** In animal models with type 2 diabetes mellitus, functional impairment of the peripheral vestibular responses to linear acceleration has been demonstrated.

**Aim:** To assess de utricular function of patients with type 2 diabetes with no history of vestibular disease compared to healthy volunteers.

**Methods:** 101 patients with type 2 diabetes mellitus (34 to 84 y.o.), receiving primary care, and 45 healthy volunteers (40 to 83 y.o.) participated in the study. They denied having a history of dizziness, vertigo, unsteadiness, hearing loss or neurological disorders. After a general health evaluation, they responded to a standardized questionnaire of balance symptoms and vestibular evaluation was performed, including rotation at 0.16 Hz and 1.28 Hz and unilateral centrifugation (300°/s peak velocity, 3.5 cm).

**Results:** In the two groups, horizontal canal function was within normal limits, as well as the static visual vertical. However, compared to healthy volunteers, patients with diabetes showed symmetric but reduced responses to unilateral centrifugation (“t” test,  $p < 0.001$ ), independently from age, evidence of polyneuropathy or the occurrence of falls.

**Discussion:** Adult patients with type 2 diabetes mellitus may have a decreased utricular function, which might be related to energy metabolism.

PP197

Other Vestibular Disorders

**EVOLUTION OF POSTIRRADIATED SUDDEN DEAFNESS IN NASOPHARYNGEAL CARCINOMA SURVIVORS DURING THE PAST TWO DECADES**Tsong-Yi CHO<sup>1</sup>, Po-Wen CHENG<sup>1</sup>, Yi-Ho YONUG<sup>2</sup><sup>1</sup>Department of Otolaryngology, Far Eastern Memorial Hospital, Taiwan<sup>2</sup>Department of Otolaryngology, National Taiwan University Hospital, Taiwan

**Objective:** The beneficial effect of intensity-modulated radiotherapy (IMRT) on reducing the prevalence of postirradiated sudden deafness (PISD) in nasopharyngeal carcinoma (NPC) survivors has never been mentioned. This study investigated the evolution of PISD in NPC survivors during the past two decades.

**Methods:** Of the 3,206 NPC patients who underwent radiotherapy during the past two decades, 32 patients (34 ears) had PISD. Twenty-nine patients (30 ears) received two-dimensional radiotherapy (2DRT) and were assigned to group A, whereas three patients (4 ears) undergoing IMRT were assigned to group B. An inner ear test battery including audiometry, vestibular-evoked myogenic potential (VEMP) test, and caloric test was performed for comparison between the two groups.

**Results:** Group B (0.2%) showed significantly lower prevalence of PISD than group A (2%). Percentages of abnormal pursuit, saccade, and optokinetic nystagmus test results revealed nonsignificant difference between groups A and B. Likewise, both groups did not differ significantly in the percentages of abnormal pure tone average, cervical VEMP test, and caloric test. However, significant hearing improvement after treatment was identified in group B ( $P < 0.01$ ) but not in group A ( $P > 0.05$ ), probably because mean radiation dosage to the cochlea of group B ( $35 \pm 0.4$  gray units [Gy]) was less than group A ( $50 \pm 3$  Gy).

**Conclusion:** Compared to 2DRT, both radiation dosages to the cochlea and radiation damage to tissues surrounding the inner ear are lessened by IMRT. Therefore, NPC survivors who received IMRT have a low prevalence of PISD, with significant hearing improvement after treatment.

PP198

Perilymphatic Fistula

**CLINICAL PERILYMPH FISTULA RESULTING FROM MICROFISSURE NEAR THE ROUND WINDOW NICHE; A CASE REPORT**Toshizo KOIZUMI<sup>1</sup>, Toru SEO<sup>1</sup>, Kazuya SAITO<sup>1</sup>, Katsumi DOI<sup>1</sup><sup>1</sup>Department of Otorhinolaryngology, Kindai University, Japan

**Background:** Perilymph fistula (PLF) is a syndrome with specific disorders of hearing, balance, or both by perilymphatic leakage due to an abnormal opening between the inner ear and the external surface of the labyrinth capsule. Its most cause is pressure-altering event. PLF is also caused by tiny bony fissure between bottom of the round window niche and the ampulla of posterior semicircular canal. However, few clinical cases have previously been confirmed. We now report a new case.

**Case report:** A 50-year-old man complained of tinnitus like as wind blowing of the left ear and the floating sensation when he touched his left external auditory canal on March 15. He visited our clinic on 17 March. The audiogram showed left sensorineural hearing loss (43.3dB). Existence of PLF was suggested then he was hospitalized to keep head-up position. The next day, he complained of severe vertigo with worsening hearing level. We performed the exploratory tympanotomy on March 21 and found accumulating pellucid fluid at the bottom of round window niche. The leaking point was packed with small pieces of connective tissue. After the surgery, his hearing and balance problems were improved.

**Discussion:** The most controversial point should be whether the leaking fluid was perilymph. We strongly suggested the perilymph leakage due to the following reasons. The first, the leaking point was consonant with the location of microfissure detected by the 3-dimensional reconstructed image of the previous histological study. The second, the progressive symptoms improved immediately after surgery.

PP199

Pharmacotherapy

**THE EFFECT OF COMMONLY USED ORAL MEDICINES IN THE THERAPIES OF MENIERE'S DISEASE****Wuqing WANG<sup>1</sup>**, Jingjuan SHI<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Eye Ear Nose & Throat Hospital of Fudan University, China***Objects:** To compare the therapy effect of common oral medication to the Meniere's disease.**Methods:** 343 Meniere's disease patients were treated with seven different solutions, including: Betahistine (43 patients), Corticosteroids (48 patients), Diuretic (52 patients), combined use of Corticosteroids and Betahistine (48 patients), combined use of Betahistine and Diuretic (46 patients), combined use of Corticosteroids and Diuretic (50 patients), combined use of Betahistine, Corticosteroids and Diuretic (56 patients). The follow up duration were from 18 to 24 months.**Results:** The improvement rate of symptoms (dizziness/tinnitus/hearing) were (46.5% 14.0% 7.0%), (91.7% 33.3% 4.2%) and (98.1% 94.2% 5.7%), respectively by alone using Betahistine, Corticosteroids and Diuretics. The results were statistically significant ( $p < 0.05$ ) in between Corticosteroids, Diuretic and Betahistine in the improvement of dizziness and tinnitus. But the results among the seven solutions are not statistically significant in the improvement of hearing ability.**Conclusions:** Amongst the seven medical treatment therapy, the treatment applying the group of Diuretic has been proven statistically to be most effective in easing symptoms of dizziness and tinnitus, followed by Corticosteroids, and then Betahistine.

PP200

Pharmacotherapy

**GOSHUYUTO – A TRADITIONAL JAPANESE ALTERNATIVE THERAPY FOR SUBJECTIVE DIZZINESS WITH MIGRAINE****Hiroaki FUSHIKI<sup>1</sup>**, Reiko TSUNODA<sup>1</sup>, Hirozo GOTO<sup>2</sup><sup>1</sup>*Department of Otolaryngology, Mejiro University Ear Institute Clinic, Japan*<sup>2</sup>*Department of Kampo Medicine, Hokusei Hospital, Japan***Objective:** Among approximately 140 formulations, Goshuyuto is a representative KAMPO medicine (traditional Japanese herbal medicine) for migraine. We investigated the effects of Goshuyuto on patients who had subjective dizziness with migraine.**Methods:** We reviewed the medical records of 38 patients with dizziness and accompanying headache who received Goshuyuto therapy between April 2014 and March 2015. Data retrieved from the medical records included neuro-otological and brain MRI findings, patient characteristics based on oriental medicine, and types of headache. In addition, State-Trait Anxiety Inventory (STAI) and Self-Rating Depression Scale (SDS) scores at the first visit, and disease course and outcomes were retrieved. Here we report outcomes after 3–4 weeks of Goshuyuto therapy for 10 patients (male, 1; female, 9) with subjective dizziness and accompanying migraine; these patients had normal neuro-otological functions and brain MRI findings, were sensitive to cold corresponding to the Yin condition.**Results:** Goshuyuto therapy for 3–4 weeks was effective for dizziness (cessation in 5, improvement in 3, unchanged in 2). Goshuyuto was also effective for migraine (cessation in 1, improvement in 6, unchanged in 3). A diagnostic scoring system correlated closely with the quality of patient characteristics and indicated that the study participants tended to have blood deficiency and/or stasis of body fluids.**Conclusion:** As per 2011 statistics, in Japan, 89% of Japanese physicians used KAMPO formulations in their daily practice, either as a single therapy or in combination with modern drugs. Based on patient characteristics, Goshuyuto is the preferred alternative therapy for migraine-associated dizziness/vertigo.

PP201

Pharmacotherapy

**INTRATYMPANIC DELIVERY OF GINKGO BILOBA EXTRACT IN UNILATERALLY LABYRINTHECTOMIZED RAT**Dongju LEE<sup>1</sup>, Mi Joo KIM<sup>2</sup>, Nam Beom KIM<sup>3</sup>, Gyu Cheol HAN<sup>1</sup><sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea*<sup>2</sup>*Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea*<sup>3</sup>*Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea*

**Objective:** The beneficial effect of EGb 761(=Ginkgo biloba extract, GBE) on vestibular compensation has been demonstrated in preclinical and clinical studies. Molecular weight (M.W) is a factor that determines the permeability of the round window. GBE is a natural mixture of ginkgolides, especially ginkgolide B, and bilobalide. The M.W of GBE has not been known. Considering that Ginkgolide B, which is a major component of GBE, has a M.W of 424.4 Da, the therapeutic potential remains unclear.

**Materials and methods:** Experiments were performed in 5 Sprague-Dawley rats. All animal received an intratympanic instillation of GBE (3.5 mg/ml) after unilateral labyrinthectomy for 7 every days at the operated side. The evaluation of vestibular function was measured at pre-treatment day and the last day for treatment by VOR on 0.04, 0.08, 0.16, 0.32Hz cycle on 100% peak velocity. Furthermore, we tilt the axis to 30° and rotated over 10 cycles to cause step velocity stimulation. From the achieved nystagmus data we made 3D analysis.

**Results:** The gain of treated rats at 7 days was  $0.093 \pm 0.042$ ,  $0.157 \pm 0.083$ ,  $0.465 \pm 0.395$ ,  $0.196 \pm 0.035$  under 0.04–0.08–0.16–0.32 Hz earth vertical rotation stimulations respectively in horizontal nystagmus data. Those results was not significant comparing with untreated one.

**Conclusion:** GBE did not show any treatment effect in unilateral labyrinthectomized rats. It is reasonable to believe that GBE molecules fail to penetrate labyrinth barrier due to its high molecular weight.

PP202

Spatial Orientation

**BILATERAL VESTIBULAR LOSS, BUT NOT PARABOLIC FLIGHT, REDUCES CELL PROLIFERATION IN THE RAT DENTATE GYRUS**Catherine GLIDDON<sup>1</sup>, Yiwen M ZHENG<sup>1</sup>, Phillip AITKEN<sup>1</sup>, Lucy STILES<sup>1</sup>, Martin HITIER<sup>2</sup>, Marie-Laure MACHADO<sup>3</sup>, Bruno PHILOXENE<sup>3</sup>, Pierre DENISE<sup>3</sup>, Cynthia L DARLINGTON<sup>1</sup>, **Paul F SMITH**<sup>1</sup>, Stéphane BESNARD<sup>3</sup><sup>1</sup>*Department of Pharmacology And Toxicology And the Brain Health Research Centre, School of Medical Sciences, University of Otago Medical School, Dunedin, New Zealand*<sup>2</sup>*Department of Otolaryngology-head And Neck Surgery And Department of Anatomy, Chu De Caen And Unicaen, Caen, France*<sup>3</sup>*Department of Inserm, U 1075 Comete Caen, France*

The aim of this experiment was to determine whether changes in gravity during parabolic flight would alter cell proliferation in the hippocampal dentate gyrus of rats with bilateral surgical vestibular deafferentation (BVD) or sham surgery, by measuring the number of bromodeoxyuridine (BrdU)-incorporated cells. Rats were randomly allocated to the following experimental groups: (1) sham surgery only ( $n = 5$ ); (2) BVD surgery only ( $n = 5$ ); (3) sham surgery and parabolic flight ( $n = 5$ ); (4) BVD and parabolic flight ( $n = 6$ ). Forty-two days following the surgery, the animals were subjected to parabolic flight under anaesthesia. A modified Airbus A300 aircraft was flown on a parabolic path 31 times, which created about 20 secs of 1.8 g during both climbing and descending and about 25 secs of 0 g at the apex of each parabola. The no flight animals were under the same anaesthesia for the same duration. One day after the parabolic flight, animals were injected with BrdU (300 mg/kg, i.p). Twenty-four hs after BrdU injection, rats were anaesthetised, cardiac-perfused and serial 40  $\mu$ m sagittal sections were cut according to a random, systematic sampling design. BrdU immunolabelling was performed and the number of BrdU positive cells was quantified using a modified fractionator method. BVD caused a large and significant reduction in cell

proliferation ( $P \leq 0.0001$ ); however, side, flight, and all interactions were non-significant. These results indicate that BVD significantly decreased the number of BrdU-positive cells compared to sham-operated animals, irrespective of parabolic flight.

PP203

Spatial Orientation

**PREDICTABLE VERTICAL TARGETS ACQUISITION – THE EYE-HEAD COORDINATION AND THE TRIGGERING EFFECT**

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The current study was designed to investigate target acquisition in the vertical plane with emphasis on establishing strategy differences associated with acquisition triggering methods.

Eight subjects were tested. Measurements consisted of target acquisition time, eye-head latency differences, velocity of gaze, eyes and head, and head amplitude. Using three-way repeated measures ANOVA the results show that the strategy for acquisition of predictable visual targets in vertical plane with the head unrestrained significantly depended on: (i) the direction of the gaze motion with respect to the gravity vector (i.e. there is significant up-down asymmetry); (ii) the angular distance of the target and (iii) the method of triggering the command to acquire the target – external versus internal. The data also show that when vertical acquisition is compared with triggering methods in the horizontal plane there is a difference in overall strategy for the acquisition of targets with the same spatial distances from straight ahead gaze when both the eyes and head are used.

Among the factors contributing to the difference in strategy for vertical target acquisition are: the gravitational vector, the relationship of target displacement and vestibular activation, biomechanical and neural control asymmetries and the difference in the vertical field of view.

PP204

Superior Canal Dehiscence Syndrome

**ELECTROCOCHLEOGRAPHIC FINDINGS IN SUPERIOR CANAL DEHISCENCE SYNDROME**

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We evaluated the electrocochleographic findings of patients with superior canal dehiscence(SCD) syndrome. Fourteen symptomatic SCD patients(1 bilateral) were recruited. Results of audiologic tests (audiometry, cervical vestibular evoked myogenic potential(cVEMP), electrocochleography(ECoG)) for 15 affected and 13 unaffected ears were evaluated. Relationships between summing potential(SP) to action potential(AP) ratios, as measured by ECoG, and other audiometric parameters were evaluated. Sensitivity analysis of SP/AP ratios was performed by plotting ROC curves for SCD syndrome patients and 19 age-matched healthy controls(38 ears). ECoG data of 30 patients with definite Meniere's disease(MD) were also compared. Mean SP/AP ratio of SCD ears was significantly higher than that of unaffected ears ( $p < 0.001$ ) and SPs were elevated in affected ears ( $p = 0.011$ ). SP/AP ratio showed a sensitivity of 92.3% and a specificity of 94.0% for distinguishing SCD syndrome patients given the inclusion criteria applied at a cutoff value of 0.34 ( $p < 0.001$ ). SP/AP ratio was not correlated with SCD size or cVEMP threshold in affected ears. Negative absolute values of bone conduction at low frequency tended to increase with SP/AP ratio. There was no difference in SP/AP ratio between MD patients' affected ears and normal ears ( $p = 0.665$ ), while affected ears in SCD syndrome patients showed higher SP/AP ratios than normal ears. Six patients underwent surgical repair showed normalization of SP/AP ratios. ECoG appears to be a valuable diagnostic adjunct for functional demonstration of the third window in the otic capsule with high sensitivity and specificity, and thus, can support a clinical diagnosis of SCD when used in conjunction with clinical and radiological findings.

PP205

Superior Canal Dehiscence Syndrome

**CAN WE ENHANCE THE ACCURACY OF THIRD WINDOW SYNDROME?****Jonathan ESTEBAN SANCHEZ**<sup>1</sup>, Ricardo SANZ FERNANDEZ<sup>1</sup>, Eduardo MARTIN SANZ<sup>1</sup><sup>1</sup>*Department of Otolaryngology, University Hospital of Getafe, Spain*

**Introduction:** Minor described the superior canal dehiscence (SCD), a condition characterized by pulsatile tinnitus, autophony, and dizziness provoked by loud sounds or Valsalva maneuver. To make a diagnosis is necessary a computed tomography (CT) to identify a dehiscence of the arcuate eminence. CT can overestimate the dehiscence so it's necessary a test to confirm the third window syndrome (TWS) instead of clinical manifestations.

**Material and methods:** We present a retrospective study with 30 patients (39 affected ears). A clinical cohort (19 cases) was defined with those patients with radiological dehiscence and symptoms of TWS and clinical manifestations described previously. In the other hand the radiological cohort (20 cases) are those patients with only a radiological dehiscence and no clinical symptoms. All patients underwent a CT scan, complete auditory test, cervical and ocular VEMPs at 500 Hz and 1000 Hz tone burst and a extratympanic electrocochleography to identify electrophysiological findings in these populations.

**Results:** Auditory results: Clinical cohort has lower bone conduction threshold with greater conductive component. VEMPs: Clinical cohort's cervical and ocular VEMPs have significant lower thresholds and greater amplitude ( $p < 0.05$ ). 100% and 20% of clinical and radiological cohort respectively had a positive 1 kHz c-VEMP and 85% and 10% respectively in o-VEMPs. EchoG: There are no significant differences in SP/AP ratio when we compared both ears neither in radiological nor clinical cohort

**Conclusions:** VEMPs results were less indicative of TWS in radiological cohort. EchoG results can't differentiate patients with TWS of those with only a radiological dehiscence.

PP206

Traumatic Brain Injury

**CLINICAL CHARACTERISTICS OF THE PATIENTS WITH DIZZINESS AFTER CAR ACCIDENTS****Young-Min HAH**<sup>1</sup>, Chul-Won YANG<sup>2</sup>, Sang-Hoon KIM<sup>3</sup>, Seung-Geun YEO<sup>4</sup>, Moon-Suh PARK<sup>5</sup>, **Jae-Yong BYUN**<sup>6</sup><sup>1</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, Kyung Hee University Hospital At Gangdong, Seoul, Korea*<sup>2</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, Kyung Hee University Hospital At Gangdong, Seoul, Korea*<sup>3</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, School of Medicine, Kyung Hee University, Seoul, Korea*<sup>4</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, School of Medicine, Kyung Hee University, Seoul, Korea*<sup>5</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, Kyung Hee University Hospital At Gangdong, Seoul, Korea*<sup>6</sup>*Department of Otorhinolaryngology – Head & Neck Surgery, Department of Otorhinolaryngology – Head & Neck Surgery, Kyung Hee University Hospital At Gangdong, Seoul, Korea*

From car accidents, different types of dizziness can occur from variety of forms of damage in static organs. Since accurate diagnosis is important for providing a proper treatment, this study evaluates the clinical characteristics related to vestibular function of the patients with dizziness after car accidents.

From January 2011 to March 2013, total of 104 consecutive patients with dizziness after car accident were enrolled. We evaluate the types of trauma during car accident and the type related to dizziness. Only patients having dizziness within 6 months from the accidents were included and patients with fracture in temporal bone or the history were excluded from this study.

In types of trauma, There were 45% whiplash injury, 25% head injury, 15% complex injury and the rest was unknown of type. Types of dizziness symptoms were 30% disequilibrium, 70% vertigo, 32% with audiological symptoms,



followed by earfullness, tinnitus and hearing disturbance. After hearing tests, 15% (9 people) of patients had hearing disturbance, and among these patients 2 had conductive hearing loss. 75% patients had dizziness with headache and 21% of them showed type of migraine. In final diagnosis of dizziness, there were 55% BPPV, 20% cervicogenic vertigo, 12% labyrinthine concussion, 3.5% delayed endolymphatic hydrops, 5% migraine associated vertigo(MAV) and 5% with ossicular abnormality. 8 patients were considered as psychogenic dizziness.

Recently, number of patients with dizziness due to car accidents is rising, and the types and symptoms of dizziness is variable. Therefore, accurate diagnosis is critical for proper approach to these patients.

PP207

Traumatic Brain Injury

### CENTRAL VESTIBULAR IMBALANCE IN ACUTE HEAD TRAUMA

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**Objectives:** Imbalance is common in head injury. The brain mechanisms mediating acute post-concussion imbalance are unclear.

**Subjects & Methods:** Acute head trauma patients with normal peripheral vestibular function (+ control group) were assessed using posturography and Sport Concussion Assessment Tool ('SCAT3').

**Results:** Ten patients (7 male, mean-54yrs; admission GCS: 3–14) with normal peripheral vestibular function were recruited. Sway was assessed under 4 conditions (Williams balance order): vision present/absent (Vi+/Vi-) and joint position sense present/absent (Pr+/Pr-). The P- condition was obtained by computer-controlled movement of the standing base that kept the ankle joint angle constant irrespective of sway. Vestibular input was always present. Patients' sway was only worse than controls in the vestibular dependent condition (i.e. Vi-/Pr-) when patients sway was significantly worse than controls [ $2 \times 2 \times 2$  ANOVA: interaction  $P = 0.05$  for Group x Pr x Vi]. For SCAT3 testing, patients' balance score was worse than controls (main effect for group x test:  $2 \times 3$  ANOVA;  $p < 0.05$ ) with tandem stance the best differentiator between controls and patients ( $P < 0.0001$ ; Bonferroni corrected).

**Conclusions:** Post-concussion imbalance is mediated by central vestibular dysfunction. Tandem stance (SCAT3) is a sensitive indicator of head injury. Thus patients' imbalance is less visible when walking and more prominent under static balance conditions, which is opposite to cerebellar ataxia.

PP208

Vascular Vertigo

### A CASE OF CERVICAL VERTIGO

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There are many cases of so called "cervical vertigo", but this case report focuses on vertigo and nystagmus occurring due to the neck or head movement. We experienced a case of cervical vertigo regarded as Bow Hunter Syndrome. A 47 y.o. female was referred from a clinic to our hospital on the chief complaint of vertigo caused by rotating her neck to the left since a few month ago. After rotating her neck to the left for 20–30 seconds, she experienced nystagmus and dullness in her right arm. She suffered sudden nausea after the appearance of the nystagmus. The same symptoms occurred while in a sitting position and a supine position. MRI, MR-angiography, and 3D-CT showed hypoplasia of right vertebral artery. Doppler echo showed the decrease of VA flow because of her neck rotation. We diagnosed her as having Bow Hunter Syndrome according to these findings. The direction of the nystagmus transitioned from leftward to downward and then rightward. She had been medicated for hypertension from a general physician, but she had noticed that her blood pressure was rather low recently. Therefore she changed the clinic and a new doctor reduced her hypertension medication. Finally, her vertigo and symptoms recovered with the improvement of her

blood pressure. Bow Hunter Syndrome is rare, so therefore we need to listen carefully to patients who report cases of vertigo occurring due to head and neck movement.

PP209

Vascular Vertigo

### ISOLATED CENTRAL VESTIBULAR SYNDROME DUE TO SUPERIOR VESTIBULAR NUCLEUS INFARCTION

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**Background:** Isolated central vestibular syndrome can result from lesions restricted to the vestibular nuclei, the nucleus prepositus hypoglossi, the flocculus, the nodulus, and the inferior cerebellar peduncle. Each structure disclose distinctive ocular motor findings, and these can aid in understanding the function of each central vestibular structure. We report a patient with dorsolateral pontine infarction who showed distinctive vestibular signs from previous central vestibular syndrome.

**Case:** A 55-years-old man presented with acute vertigo, unsteadiness, and vertical diplopia. He had no other neurological or auditory symptoms. Neurological examination showed spontaneous right-beating horizontal-torsional nystagmus that increased during rightward gaze and changed into left-beating during leftward gaze. Bedside head impulse tests were normal. He veered to the left side. Tests of subjective visual vertical showed conjugated rightward deviation. Fundus photography revealed a rightward ocular torsion. He had a skew deviation with a left hypertropia. Bithermal caloric tests and a vestibular-evoked myogenic potential test were normal. Diffusion-weighted images revealed an acute, tiny infarction on the right dorsolateral pons, and magnetic resonance angiography disclosed no abnormalities. He was treated with antiplatelet agent, and his symptoms resolved within 2 weeks of symptom onset.

**Conclusion:** Our patient with dorsolateral pontine infarction presented with isolated central vestibular syndrome characterized by ipsilesional spontaneous nystagmus, gaze-evoked nystagmus, normal head impulse, and ipsilesional ocular-tilt reaction. These findings are inconsistent with that observed in lesions of medial vestibular nucleus and inferior cerebellar peduncle located on the dorsolateral pons. Instead, selective involvement of the superior vestibular nucleus might explain our patient's signs.

PP210

Vascular Vertigo

### TRANSIENT VESTIBULAR SYMPTOMS PRECEDING ACUTE VESTIBULAR SYNDROME

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**Objective:** Recent studies reported that preceding transient isolated brainstem symptoms are common in patients with a completed stroke in the vertebrobasilar territory. However, transient isolated brainstem symptoms including isolated transient vestibular symptoms (TVSSs, isolated vertigo or unsteadiness) are not consistently classified as transient ischaemic attacks (TIAs). We aimed to assess the frequency and characteristics of TVSSs before acute vestibular syndrome (AVS) due to stroke.

**Methods:** We prospectively recruited patients with acute vestibular syndrome due to stroke in Emergency Department of Busan National University Hospital from May, 2015 to 2016. We studied all potential vestibular symptoms during the 90 days preceding acute vestibular syndrome due to stroke with a standardized questionnaire which included date of symptom onset, duration and type of symptoms, baseline characteristics, and time of first seeking medical attention.

**Results:** Overall frequency of TVSSs was 10% of the 250 patients with AVS due to stroke. Of 25 TVSSs preceding AVS due to stroke, only three (12%) fulfilled the National Institute of Neurological Disorders and Stroke (NINDS)

criteria for TIA. The other 22 cases were isolated vertigo ( $n = 12$ ) or unsteadiness ( $n = 10$ ). Most TVSSs (70%) occurred during the preceding one month. The duration of TVSSs was variable ranging from several minutes to hours. Only five (20%) of the 25 patients with TVAs sought medical attention before the stroke.

**Conclusion:** In patients with AVS due to stroke, preceding TVSSs are common but most symptoms do not satisfy traditional definitions of TIA which suggests that broader diagnostic criteria of TIA are needed.

PP211

Vestibular and Inner Ear Physiology

### **DECLINE OF CHOLINERGIC EFFERENT TRANSMISSION IN AGEING MOUSE VESTIBULAR ORGANS**

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**Introduction:** Degeneration of cholinergic networks has long been associated with ageing, and is not confined to memory and cognitive pathways of the forebrain. Cholinergic control of diverse peripheral functions such as cardiovascular rate, smooth muscle contraction, gastrointestinal motility, and gland secretion has also been reported to change with age. It is not known how age-related decline in peripheral vestibular function is related to its cholinergic efferent innervation.

**Methods:** Using patch clamp electrophysiology, we measured the current responses of type II hair cells to application of 300  $\mu\text{M}$  acetylcholine in cristae of mice aged 3 weeks (juvenile), 3 months (adult),  $\sim$ 28 months (aged). Antagonists against nicotinic acetylcholine receptors containing alpha9 subunit (strychnine; 1  $\mu\text{M}$ ) and small conductance calcium-activated potassium channels, SK, (apamin; 0.1  $\mu\text{M}$ ) were used to characterize channel activation in response to ACh. In addition, using RT-PCR, the expression levels of acetylcholine receptor mRNA in the cristae of mice aged 2.5, 8, 14, and 26 months were compared.

**Results:** Preliminary evidence shows the peak amplitude and duration of ACh evoked responses were reduced in the aged cohort compared to juvenile mice. This was attributed to a decrease in both alpha9 nicotinic receptor subunit and SK channel conductances. Similarly, there was a large ( $\sim$ 50%) concomitant decrease in alpha9 nicotinic receptor subunit mRNA in the cristae of aged mice compared to young adult controls.

**Conclusions:** Age-related vestibular decline is likely to involve the peripheral cholinergic efferent system as our data show significant decreases in expression and function of alpha9 subunit nicotinic receptors with increasing age.

PP212

Vestibular and Inner Ear Physiology

### **DEVELOPMENT OF THE HUMAN VESTIBULAR SYSTEM – WHEN DO HAIR CELLS BECOME FUNCTIONALLY ACTIVE?**

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**Background:** An indication of mature vestibular hair cells includes the presence of functional mechano-electrical transduction (MET) channels in stereociliary bundles and the capacity for basolateral neurotransmitter release. We examined when MET channels became active in human fetal vestibular hair cells, and if hair cells were capable of transmitter release.

**Methods:** All procedures were approved by The University of Newcastle Human Ethics Committee. Human tissue aged between 11–15 weeks gestation (WG) was collected and inner ears isolated. To determine if MET channels were functionally active, we injected the styryl dye, FM1-43, into the membranous canals, and the exposed cristae were observed using confocal imaging. To determine if fetal hair cells can release neurotransmitter we monitored ex-

ocytosis dependent changes by recording whole-cell electrical capacitance during the summation of three sinusoidal voltage commands at fixed depolarizing steps.

**Results:** Imaging of FM1-43 shows immunofluorescent labelling in stereocilia and apical poles of some fetal vestibular hair cells of the cristae and utricle aged between 11–15 weeks gestation (WG). Preliminary data also shows ~50% of hair cells recorded had an average increase in capacitance with depolarizing steps (60 fF after 1 s; 200 fF after 4 s), and is consistent with basolateral neurotransmitter release.

**Conclusions:** There are a proportion fetal hair cells have functional MET channels. A subset of hair cells also show increased capacitance after depolarization, suggesting hair cells are releasing neurotransmitter. This suggests the cellular machinery for mechanosensory transduction is expressed in a subset of fetal vestibular hair cells from 11WG.

PP213

Vestibular and Inner Ear Physiology

**EFFECT OF ROUND WINDOW PERFUSION OF ISOSORBIDE FOR ENDOLYMPHATIC HYDROPS IN VASOPRESSIN-INDUCED ANIMAL MODEL**

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Isosorbide (ISB) reduces the volume of endolymph and its oral administration is clinically effective in patients with Ménière's disease. The purpose of this study was to evaluate the effect of ISB round window perfusion (RWP) on vestibular imbalance in a new acute attack hydrops model. Seventy male Hartley guinea pigs were used. Isosorbide was applied via RWP and oral administration (PO). Perilymph was collected through the round window membrane and intracochlear concentration was analyzed using HPLC. Acute aggravation of hydrops was induced by desmopressin (VP). Auditory and vestibular functions were measured before and after ISB treatment using auditory brainstem response (ABR) test and bidirectional sinusoidal harmonic acceleration (SHA) test with an animal rotator, respectively. The result showed that ISB of 25%, 50%, and 100% can pass the round window membrane after RWP, and RWP with 50% and 100% ISB showed higher intracochlear concentrations than 25% ISB. VP successfully induced temporary asymmetric vestibular function in guinea pigs with surgically ablated endolymphatic sacs. In the normal guinea pigs, transient vestibular imbalance was observed after RWP of 50% ISB, but not after RWP of 25% ISB. Especially, RWP of 25% ISB preserved symmetric vestibular function against VP at the acute attack hydrops model. In conclusion, ISB was able to pass the round window membrane into the perilymphatic space, and RWP of ISB preserved symmetric vestibular function in the acute hydrops model induced by VP. Thus, RWP such as intratympanic injection of ISB could be a candidate treatment for vertigo attack in Ménière's disease.

PP214

Vestibular Compensation and Rehabilitation

**EFFECTS OF VIRTUAL REALITY EXERCISE PROGRAM ON BALANCE AND QUALITY OF LIFE AMONG PATIENTS WITH CENTRAL TYPE VERTIGO.**

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**Purpose:** The purposes of this study were to evaluate the effectiveness of an 8-week virtual reality exercise program designed around the Nintendo Wii(Wii), in improving balance and quality of life among patients with central type vertigo(CV).

**Methods:** The subjects were 30 individuals with CV. 15 patients were assigned to experimental group to engage an in three 40-minute Wii balance-training sessions per week, for 8 weeks, and 15 to control group. They were asked to complete questionnaires including verbal analogue scale (VAS), activities-specific balancing confidence scale (ABC), and fall index assessment before and after the intervention. Quantification of improvement was conducted utilizing Sensory Organization Test (SOT) of Computerized Dynamic Posturography (CDP). Statistical significance was tested in between the patients before and after treatment by ANOVA.

**Results:** There was a statistically significant improvement in scores of VAS, ABC, and fall index assessment results within the experimental group. SOT showed significant difference on condition 5, 6, and vestibular ratios within the experimental group from baseline to post-intervention.

**Conclusions:** Virtual reality exercise program can be an effective intervention method improving balance, balance confidence, and qualities of life among individuals with CV.

PP215

Vestibular Compensation and Rehabilitation

### EFFECTIVENESS OF SELF-EFFICACY PROMOTING VESTIBULAR REHABILITATION FOR PATIENTS WITH VESTIBULAR HYPOFUNCTION

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**Purpose:** This study examined the effect of self-efficacy promoting vestibular rehabilitation program (S-VRP) on dizziness, exercise self-efficacy, adherence to VRP, subjective & objective vestibular function and vestibular compensation in patients with vestibular hypofunction.

**Methods:** This study was a randomized controlled. Outcome measures were level of dizziness, exercise self-efficacy, level of adherence to VRP. Subjective & objective vestibular function and vestibular compensation were also obtained. The data were collected 3 times at baseline, 4 & 8 weeks after the beginning of the program. Data were analyzed using Windows SPSS 21.0 program.

**Results:** Of 38 randomized participants, 30 (78.9%) completed all clinical measures (The experimental group 16, control group 14). After 4 weeks of S-VRP we found that dizziness, subjective & objective vestibular function were not different between the groups although exercise self-efficacy, adherence to VRP were higher in the experimental group than in the control group. On the other hand after 8 weeks of S-VRP, dizziness ( $p = 0.018$ ) exercise self-efficacy ( $p < 0.001$ ), adherence to VRP ( $p < 0.001$ ), subjective vestibular function ( $p = 0.012$ ), vestibular compensation (composite-sensory organization test ( $p = 0.018$ ) & vision analysis ratio ( $p = 0.046$ )) in the experimental group differ significantly from those in the control group.

**Conclusion:** Our results indicated that continuous 8 weeks of S-VRP was more effective on reducing dizziness, and improving exercise self-efficacy, subjective vestibular function & adherence to VRP than usual VRP. Objective vestibular function, vestibular compensation were also partly improved in the experimental group at the end of 8 weeks of S-VRP.

PP216

Vestibular Compensation and Rehabilitation

### PAIN IS COMMON BOTH IN PATIENTS REFERRED TO A VESTIBULAR CLINIC AND PATIENTS REFERRED TO A PSYCHIATRIC CLINIC

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**Background:** Persistent dizziness and psychiatric disorders cause suffering for the individual, and raises questions about how to best approach within the healthcare system. Patients with these disorders are seen by different medical specialities, which might be effective but carry a risk of missing valuable aspects. Multidimensional information about comorbidities, such as pain, would provide a fuller background for rehabilitation.

**Methods:** Patients with balance disorders ( $n = 49$ ), referred to a vestibular clinic, and patients with anxiety or depression ( $n = 62$ ), referred to a psychiatric clinic, replied to questionnaires about dizziness (Dizziness Handicap Inventory) and pain, complemented with pain drawings.

**Results:** 65% of the patients with balance disorders reported concomitant pain. Among those, 50% reported that the two symptoms started within a year of each other. Pain in the neck, head and arms was most common. 58%

of the patients referred to a psychiatric clinic reported pain, and 44% reported dizziness. 24% of the patients with balance disorders and 13% of the patients with psychiatric problems reported their symptoms to be associated with an accident.

**Conclusion:** If a patient has dizziness it is also quite possible that this patient suffers from pain. Dizziness and pain are also common in patients with psychiatric disorders. The results indicate a multifactorial maintenance of symptoms. The results further advocate a multidisciplinary approach, both for diagnostic and rehabilitation purposes.

PP217

Vestibular Compensation and Rehabilitation

### **VALIDATING A QUESTIONNAIRE TO MEASURE SELF-EFFICACY IN PEOPLE WITH DIZZINESS**

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**Introduction:** Symptoms of dizziness often bring about changes in lifestyle, such as reduced participation, avoidance of activities of daily living (ADL) and reduced health-related quality of life. Research across a diverse range of chronic illnesses has shown that a person's self-efficacy is associated with health status, health behaviour and health behaviour change. A person's self-efficacy has demonstrated to be amenable to change, thus it is an important factor to measure in rehabilitation and to use in interventions to influence other health related outcome measures.

**Purpose:** To investigate the content validity of a questionnaire measuring self-efficacy for ADL and symptom management in people with dizziness.

**Methods:** A newly developed questionnaire containing 61 questions was validated using a combination of two methods; modified Delphi and Content Validity Index (CVI). Three expert groups were recruited; 10 persons with dizziness, 10 clinicians, and 10 researchers with expertise in self-efficacy and social cognitive theory. Data from the CVI and Delphi were analyzed, summarised and then returned to the expert groups for new validation.

**Results:** After three rounds of Delphi and CVI, six items were endorsed by all expert groups without any revisions, 36 items were reformulated, five items were added, and nine items were eliminated. The revised questionnaire now contains 47 items where 41 measure self-efficacy for ADL and six measure self-efficacy for symptom management.

**Conclusion:** The validation resulted in broad and detailed perspectives on self-efficacy and dizziness. The final questionnaire's intended use is to aid in the assessment and rehabilitation of persons with dizziness.

PP218

Vestibular Migraine

### **BALANCE ALTERATIONS DURING CHILDHOOD. PREVAILING ETHIOLOGIES ACCORDING TO AGE**

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Balance alterations are a very common cause of consultation in adult patients but less usual in the pediatric population. When this symptomatology appears in children it is a great cause of concern, both for parents as for the consulted doctors.

**Objectives:** to explain our balance alterations in pediatric patients case studies and state the prevailing pathologies dividing the sample in age groups.

**Design:** A retrospective, observational, descriptive and transversal study was performed. Population: Patients 1-18 y.o. who consulted due to balance disorders at a high complexity pediatric hospital otolaryngology service between March 2012 and July 2015.

**Results:** 206 patients were included in the study. The age median was 10 years. The conditions more commonly present are: Vestibular Migraine, in 21.8% of the total of studied children, Ataxias in 9.22%, Benign paroxysmal vertigo of childhood in 7.77% and post traumatic vertigo in 6.31%. 61 VNG (46 were normal and 15 were pathologic) and 55 video Head Impulse Test (45 normal and 10 had gain alterations of the vestibulo-ocular reflex)

**Conclusions:** In the presence of a child with balance alterations, the clinical record and a thorough oto-neurologic exam are very important. Vestibular migraine is the condition most commonly found in every age group, and most patients have a family history of migraine. Complementary test, specially a video Head Impulse Test, provide very important information when confirming the suspected diagnosis

PP219

Vestibular Migraine

### **CALORIC INDUCED VERTIGO IS DISSOCIATED FROM EYE MOVEMENTS IN VESTIBULAR MIGRAINE AND MAL DE DEBARQUEMENT SYNDROME**

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Vestibular migraine (VM) and mal de débarquement syndrome (MDS) are vestibular disorders not showing abnormalities on vestibular function tests. Caloric testing remains a key clinical test of peripheral vestibular function. We considered that the relationship between caloric-evoked motion perception and eye movements would differentiate between peripheral and putative central vestibular disorders.

Dizzy patients (500) were studied with standard caloric testing by a single operator. Slow-phase velocity of horizontal eye movements (SPV) was recorded using video-oculography. After each irrigation, subjects reported perceived self-motion (0: no sensation, 1: non-specific dizziness without rotation, 2: mild spinning, 3: moderate spinning, 4: severe spinning). Clinical diagnoses were based on questionnaire and vestibular function testing.

Patients were classified as: (i) 212 peripheral vestibular disorder (BPPV, Meniere's, neuritis, bilateral failure), (ii) 171 VM or MDS, (iii) 116 uncertain or non-vestibular. Those with a clear peripheral disorder showed a strong correlation ( $r = 0.63$ ) between SPV and perception whereas VM and MDS showed only a weak correlation ( $r = 0.20$ ); highly significant difference ( $z = 5.25$ ,  $P < 0.0001$ ).

Peripheral disorders, but not VM and MDS show the predicted association between eye movements and perception. Thus, ascending vestibular signals are misinterpreted in these conditions. Work in elderly subjects has demonstrated caloric ocular-perceptual dissociation where absent perception is associated with falls<sup>1</sup>. Understanding the central vestibular system and motion perception is needed in these essentially perceptual disorders.

1. Chiarovano et al. (2016) Absence of rotation perception during warm water caloric irrigation in some seniors with postural instability. *Front Neurol.* 25

PP221

Vestibular Neuritis

### **ACUTE PERIPHERAL VESTIBULAR ASYMMETRY DISEASE – A NEW DISEASE ENTITY?**

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**Objectives:** Acute vestibular syndrome (AVS) is characterized by the rapid onset of vertigo, nausea, vomiting, gait unsteadiness and nystagmus lasting days to weeks. We report the patients mimicking vestibular neuritis without central lesion and diagnose the cases as “acute peripheral vestibular asymmetry disease(APVAD).”

**Methods:** We retrospectively reviewed the patients who were diagnosed with vestibular neuritis between 2010 and 2013. Among them, five patients showed different findings compared to vestibular neuritis without central lesion. We analyzed the patients' clinical features, clinical course, and vestibular testing.

**Results:** All patients showed spontaneous nystagmus continuing for a few days. However, head impulse test did not reveal a corrective saccade detected in vestibular neuritis. Magnetic resonance imaging (MRI) of the brain showed no abnormal lesion. The bithermal caloric test revealed directional preponderance without canal paresis. The slow harmonic test of rotary chair revealed unilateral high gain and phase within normal range, but the significant asymmetric response was found.

**Conclusion:** We described the cases as “acute peripheral vestibular asymmetry disease (APVAD),” which defines negative head impulse test and normal caloric response with spontaneous nystagmus. Our report offers useful information regarding the peripheral lesion underlying AVS.

PP222

Vestibular Neuritis

#### CHANGE IN CLINICAL INDICATORS AND SUBJECTIVE SYMPTOMS BETWEEN ACUTE AND RECOVERY PHASES OF VESTIBULAR NEURITIS

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**Objective:** The purpose of this study is to investigate change in clinical indicators and subjective symptoms between acute and recovery phases in patient with acute vestibular neuritis.

**Subjects and Methods:** A total of 35 patients from 5 tertiary medical centers were included (Mean age: 43 years). Onset to visit time was 2 days in average (range, 1–4), and 16 out of 35 was involved in the right side. Detailed Neurotologic findings from caloric test, rotatory chair test and vestibular evoked myogenic potential, and questionnaires (DHI, ABC, BAI, BDI) for subjective symptoms were recorded at the time of initial presentation (the first visit) and at the recovered stage (after 8–12 weeks). Correlation analysis between variables was performed, and change in variables between acute and recovered stage was also analyzed. A p-value less than 0.05 was regarded as significant.

**Results:** At the acute stage, score of DHI and ABC had a significant correlation ( $p = 0.004$ ). At the recovered stage, elder patients showed high DHI score ( $p = 0.004$ ), and patients with higher caloric paresis showed high DHI score ( $p = 0.003$ ). Moreover, DHI was correlated both BDI and BAI at the recovered stage ( $p = 0.003, 0.023$ ). After recovery, caloric paresis, DHI and BDI score were decreased significantly ( $p < 0.001, < 0.001, = 0.048$ ).

**Conclusion:** DHI score at the recovered stage was higher in elder patients and patients with higher caloric paresis at the recovered stage. Caloric paresis, DHI and BDI score were decreased after recovery. These clinical data could be helpful for expecting prognosis and consultation for patients with vestibular neuritis.

PP223

Vestibular Neuritis

#### ANALYSIS OF THE VOR GAIN DIFFERENCES BETWEEN RAMSAY-HUNT SYNDROME AND VESTIBULAR NEURITIS

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**Introduction:** Recovery of the vestibular function after acute vestibular neuritis is variable with an uncertain degree of reporting persistent symptoms long after the acute episode. The aim of this study is to evaluate the differences of the vestibular impairment after a vestibular insult due to a vestibular neuritis or Ramsay Hunt Syndrome.

**Material and methods:** We present a prospective and longitudinal cohort study with 10 patients with Ramsay-Hunt syndrome and 20 patients with vestibular neuritis. Every Patient in the study underwent a complete neurological examination, caloric testing and video Head Impulse Test (vHIT) in the initial evaluation. Subsequently, vHIT measurements were performed 1, 3 and 6 months after the initial clinical presentation.

**Results:** The Ramsay-Hunt syndrome cohort showed a statistically significant lower gain in both affected and healthy ear ( $p = 0.012$  and  $0.016$  respectively) when compared to the vestibular neuritis patients. Those differences in vestibular asymmetry elicited by the vHIT remained unaffected in the 1, 3 and 6 months follow-up. No significant differences were observed concerning to the initial evaluation with caloric test ( $p = 0.5$ ).

**Conclusions:** A higher vestibular impairment was observed in the Ramsay-Hunt patients in the initial evaluation and monthly follow-up, compared to the vestibular neuritis cohort.

PP224

Vestibular Neuritis

### **ACUTE PERIPHERAL VESTIBULAR DEFICIT LEADS TO DECREASED RANDOMNESS IN A RANDOM NUMBER GENERATION TASK**

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Unilateral peripheral vestibular deficit leads to biases in spatial orientation. More specifically, vestibular patients typically show a spatial bias towards their affected ear in the subjective visual vertical, head and trunk orientation, fall tendency, and walking trajectory. By means of a random number generation task, we set out to investigate how an acute peripheral vestibular deficit affects the mental representation of numbers in space. Furthermore, the random number generation task allowed us to test if patients with peripheral vestibular deficit show evidence of impaired executive functions. Previous research using galvanic vestibular stimulation in healthy people has shown no effects on number space, but revealed decreased randomness. Other studies reported a spatial bias in number representation during active and passive head motion. In this experiment, we tested 43 patients with acute vestibular neuritis (18 patients with left-sided and 25 with right-sided vestibular deficit) and 28 age-matched healthy controls. We found no bias in number space in patients with left- and right-sided vestibular deficit. However, patients were less able to produce random numbers, irrespective of lesion side. Our findings add evidence to the growing literature reporting cognitive difficulties following vestibular deficit. We argue that the random number generation task is a cost- and time-effective tool to assess executive functions in patients suffering from a peripheral vestibular deficit.

PP225

Vestibular Prosthesis

### **ELECTRICAL STIMULATION TO VESTIBULE CAN INDUCE AUDITORY SENSATION WITHOUT VESTIBULAR SYMPTOM IN COCHLEAR APLASIA**

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Galvanic vestibular stimulation (GVS) has been used to research a vestibular system in humans and experimental animals during last 200 years. GVS activates the vestibular nerve and induces nystagmus and perceptual and postural shift. Recently, vestibular implantation has been developed to restore vestibulo-ocular reflex (VOR) for patients with bilateral vestibular loss. Direct electrical stimulation to semicircular canal, utricle or saccule using vestibular implant evokes nystagmus through VOR.

Hereby, we report two children who has normally formed vestibule and three semicircular canals without cochlea. Direct electrical stimulation to the vestibule using cochlear implant electrode array positioned inside the vestibule induced clear auditory sensation without vestibular symptom and nystagmus. These cases implies that direct electri-

cal stimulation to a vestibule can evoke only auditory sensation, not VOR in children with congenital vestibular loss. Application of vestibular implantation for patients with congenital bilateral vestibular loss needs to be cautious.

PP226

Central Vestibular Disorders

**CORRELATION BETWEEN VIDEONYSTAGMOGRAPHY AND MAGNETIC RESONANCE IMAGING OF BRAIN IN PATIENTS WITH VERTIGO**

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**Objective:** Vertigo is one of the most common complaints seen at otolaryngology outpatient departments. History taking and physical examinations are crucial to differentiate between central origin and peripheral origins. However, often the symptoms and signs are non-specific and vague, we need further laboratory and image examinations. The aim of this study was to determine the sensitivity and usefulness of Brain magnetic resonance imaging (MRI) as a diagnostic tool for the patients who presented central vertigo in videonystagmographs (VNG).

**Materials and methods:** This is a prospective observational study on the patients with vertiginous symptoms. Videonystagmography was performed in all patients, and only with central ocular motor findings were included and completed further Brain MRI study. Patients who had past histories of stroke and trauma were excluded from the study.

**Results:** Among 73 patients, 31 patients (42.5%) had confirmed vertigo of central origin by the method of MRI, which include cerebral vascular disease (17/31, 54.8%), cerebral infarction (12/31, 38.7%) and posterior circulation ischemia (16/31, 51.6%). Female was dominant among those who had positive findings of VNG (38/73, 52%), but there was more male patients who diagnosed of central vertigo via MRI (17/31, 54.8%). In addition, elder patients (age > 65) were susceptible for central origins (24/31, 77.4%).

**Conclusion:** Although videonystagmography favored positive findings of the patients presented with vertigo, there were still negative results for central origin through MRI. Thus, the utility of MRI may be considered as a diagnostic method for vertiginous patients who complained of vertigo, especially among elder people.

PP227

Benign Paroxysmal Position Vertigo

**AUGMENTED REALITY FOR PARTICLE REPOSITIONING MANEUVER FOR BENIGN PAROXYSMAL POSITIONAL VERTIGO: A PRIMARY STUDY**

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**Background:** Based MRI image data of inner ear, augmented reality (AR) fuses computer-generated 3-D images of semicircular canals with real-time views of the head movement. Particle Repositioning Navigation is a navigation system with AR capabilities for Particle Repositioning Maneuver (PRM) for Benign Paroxysmal Positional Vertigo. With this technology practitioner can correctly and quickly identify the position and posture of semicircular canals during the performance of PRM.

**Purpose:** To evaluate whether the use of Particle Repositioning Navigation had a significant advantage on the performance of the PRM.

**Methods:** 20 junior doctors were recruited and performed the PRM on a healthy volunteer. One half of the junior doctors used Particle Repositioning Navigation, whereas the others used a sham system. The PRM performance scores of the two groups were compared.

**Results:** Particle Repositioning Navigation users scored significantly higher on their PRM performance compared with controls ( $P < 0.0001$ ). **CONCLUSIONS:** Particle Repositioning Navigation system with AR was easily and successfully deployed in PRM. The application of Particle Repositioning Navigation represents a significant improvement from current PRM performance.

Keywords: BPPV; Particle Repositioning Maneuver (PRM); augmented reality (AR)